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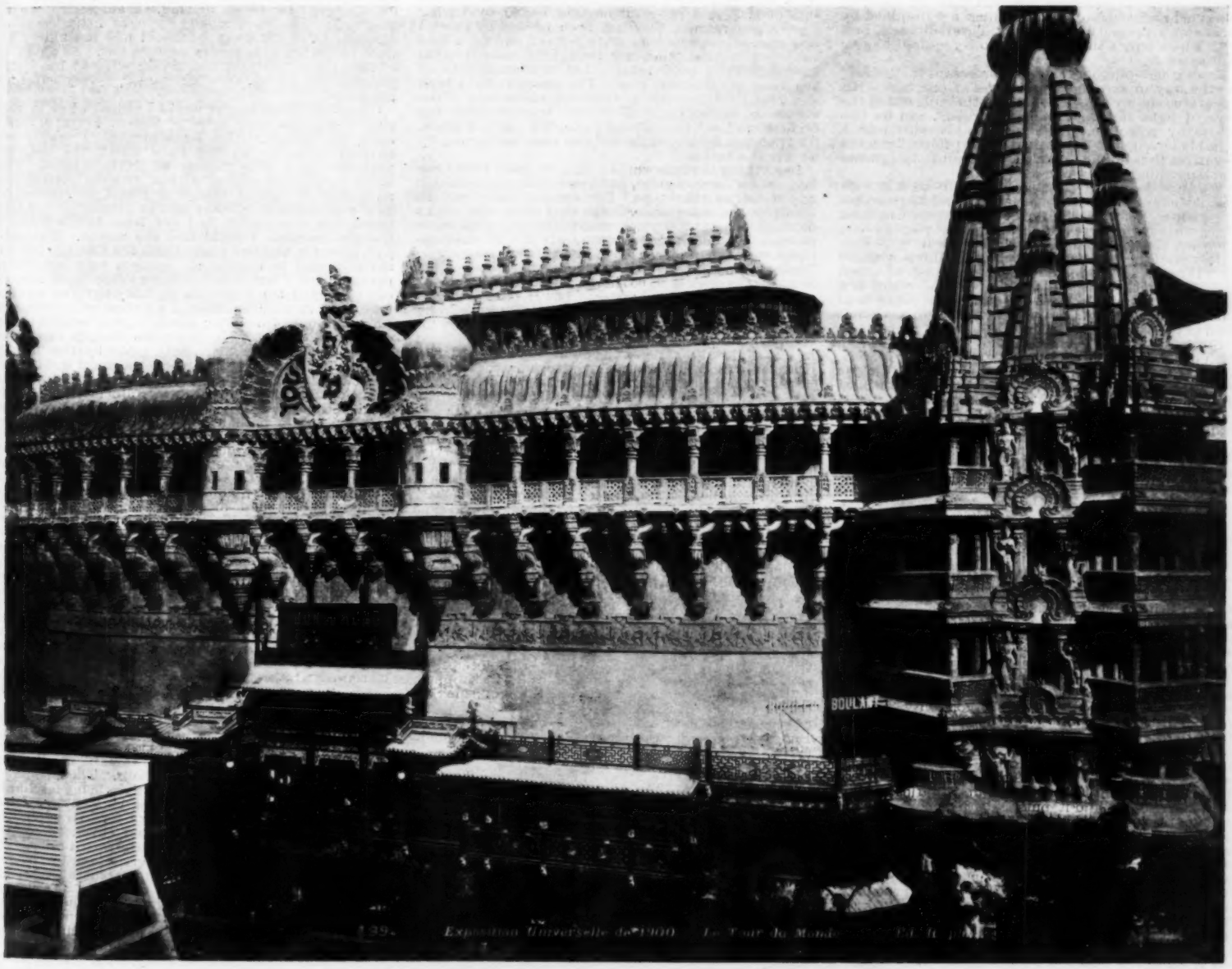
THE "TOUR DU MONDE" AT THE PARIS EXPOSITION.

AMONG the amusement features of the Paris Exposition, the panorama of a journey around the world, known as the "Tour du Monde," is the most interesting. It is situated on the Champ de Mars to the right of the entrance. The exterior of the building recalls the principal types of Chinese, Japanese, Cambodian and Hindoo architecture. Passing along a long boundary wall, ornamented with a decorative frieze, the first thing to attract attention on coming from the Quai is a great Cambodian tower, the oval dome of which has the appearance of an enormous chased miter; it is ascended by balconies upheld by caryatides, representing Buddhist genii and divinites. Advancing toward the right, we come to the principal entrance of the Panorama, originally the door of a temple at Tokio. It is made of wood, relieved with gilding, and carved with quaint dragons and fantastic animals, the enameled eyes of which are set in gold. This doorway, surmounted by a very flat roof curved upward at the ends, forms a vast portico supported by wooden columns. By the side of it is the Chinese Tower, the high and curious tower of the Garden of Niko, the roofs of which, blue above and red beneath, are piled one above the other. Further on are friezes and panels of lacquer with Chinese and Japanese drawings and inscriptions. Standing on the central platform, facing the staircase, the spectator has before him a view of one of the finest spots in Japan, under a dazzling rose-colored sky: Yeddo, buried amid blossoming apple trees, with the rosy peak of Fusiyama standing out from its mists in the background. To the right, the Garden of Niko appears with the tower. Turning to the left, a corner of a Chinese city, Shanghai, strikes the eye with its gay inclosed gardens. Then are seen the ruins of Angkor, marvelously set in a fringe of luxuriant vegetation. Thence one is carried rapidly to the monotonous horizon round Suez, to Port Said, with a view of the canal; to Constantinople, showing the Bosphorus, and the Turkish cemetery to the right, with its strange tombstones. Next comes Athens, crowned by the Acropolis; and farther on, Spain.



THE "TOUR DU MONDE," AT THE PARIS EXPOSITION.

THE HISTORY OF PHOTOGRAPHY IN NATURAL COLORS.

THE British Journal of Photography gives the following translation of a paper on this subject, read by Prof. Barbieri, of the photographic school of the Zurich Polytechnic, at the annual meeting of Swiss Photographic Societies held not long ago in Lucerne.

Two processes have been employed up to the present time for obtaining photographs in natural colors. The older of the two is direct; the other adopts the method of preparing three color sensation negatives, one for the red, one for the blue, and one for the yellow. The print is thus obtained in every tint by the mixture of these three colors.

Seebeck was the first to obtain direct colored prints. He found that the silver chloride not only deepened in tint but became colored when exposed under colored glasses. A more important observation was that of Becquerel, who found that a more exact reproduction of the colors was obtained by combining chlorine and silver by electrical means. Becquerel also made the observation that the colored result was more nearly perfect if the film were submitted to a preliminary exposure in daylight. This fact is an indirect proof that the reproduction of the colors depends more upon the action of light upon the subchloride than upon the normal chloride.

Poitevin improved on Becquerel's process by adding to the sensitive mixture substances to increase the sensitiveness to colors without, however, producing any action on the sub-salt so essential to the process. The method used by Poitevin was afterward very considerably improved by the well-known photo-chemists Krone, Kopp, Veress, Valenta, and others.

Next in the history of the direct process come the experiments of Lippmann, who followed out experimentally the process described by Zenker in 1868. This process consisted in employing a film sensitive to all colors and a mirror of liquid mercury. The rays passing through the film fall upon the mirror, by which they are reflected through the film. The reflected rays show the interference produced by the film. Lippmann's colored prints are thus not formed by any pigment. Their colors are visible only when they are viewed by reflected light, but they are none the less permanent. Others have taken up and improved Lippmann's process. I may mention Krone, Valenta, and Lumière. The last especially has produced since 1892 landscapes and portraits by Lippmann's process.

It was Lippmann who conceived the idea of replacing the bromide of silver by bichromated gelatine, but here also the coloration is seen only by reflected light. The theory of Wiener as to the production of colored images with silver compounds does not hold good in regard to these colored images in bichromated gelatine because in this latter there are no silver layers,

and Wiener's theory is based on the fact that the superimposed and reflecting layers of silver in the film are the cause of the colors. One must thus conclude that the colors are caused by reflection from the films of unchanged gelatine.

The basis of the various indirect processes of color photography is the production of three negatives by means of three different light filters—three plates sensitive to red, yellow, and blue. With these three negatives polychrome prints can be made in various ways.

De Rausonet proposed to make three negatives by means of yellow, blue, and red filters, from these three lithographic stones, and to afterward print in the appropriate colors by lithography. But this process did not give good results, for, though the negatives were taken through colored screens, the plates were not specially sensitive to the different colors. Dr. Hauron's process suffered from the same defect. He printed from his negatives in carbon, and transferred to plates of mica.

When Vogel invented color sensitive plates, Drs. Albert and Obernetter were the first to succeed with tricolor reproduction.

But there are still many difficulties to be overcome. The problem of the selection of the proper blue, yellow, and red colors is one; these three colors must be such as shall give every other color by admixture, a condition which at present cannot be fulfilled. As a matter of fact, the same three colors should be used both for sensitizing and printing, a very practical difficulty, for most sensitizers are useless for printing purposes. Hence recourse must be had to those colors which lend themselves to the printer's art, and hence, although extremely beautiful reproductions are made, fac-simile representations of the originals are, at present, not possible. Still there is no occasion to despair. Wonderful progress has already been made, thanks to the researches of, among others, Dr. Vogel, Baron Hübl, Frisch, Husnik, and Angerer. Before leaving photomechanical color processes, mention must be made of the synchromotypes of Turati, which are obtained by means of a press constructed by Turati himself, and with which only a single impression is required to give all the colors.

Among non-photo-mechanical processes, that of Ives led the way in viewing three images at one time. His apparatus simply consists of a lens through which the rays of light fall on one plate directly, and on two others by reflection. Each plate is provided with a suitable screen, and the positives thus printed from the negatives thus obtained are viewed against the glasses corresponding to the taking screens.

Vidal projects the three positives on to a screen. Nachet adopts Ives' arrangements, using stereoscopic apparatus. Selle makes three positives on collodion films, which he dyes red, blue, and yellow respectively. They are then superimposed and projected.

Joly uses the idea of McDonough, taking a single view through a ruled screen of colored bands, red, green and blue, repeated across the plate. The result is a negative of very fine lines. A positive is made from this and placed in contact with a screen similar to that used in the camera, line to line.

Stockert's process possesses much of interest. From each of the negatives made, as for the tricolor process, a print is taken in gum-bichromate, the first for the yellow, the second for the red, and the third for blue. The three prints are made on the same paper, one on top of the others, sensitizing twice more after the first printing.

Lumière similarly uses carbon. Hofmann has a similar process, in which the preparation of the negative and registration of the prints is assisted by ingeniously devised apparatus.

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* [Continued from SUPPLEMENT, No. 1289, page 20667.]

AMERICAN ENGINEERING COMPETITION *

X.—STATIONARY ENGINES.

IT has for some time past been known to well-informed British engineers that the manufacture of large stationary steam engines has been increasing to a very remarkable degree in the United States. This has also been brought before the general public by the instance of the Glasgow tramways, to which reference will be made later. The increased activity is reflected slightly in the export business of the country, though manufacturers have been mostly too busy to seek foreign orders. By reference to official figures it will be found that the exports of stationary engines from the United States have increased 200 per cent. during the last ten years. Our exports have been falling away steadily for some time, being about 33 per cent. less in 1898 than in 1888. Statements of ratios are apt to be misleading, and it puts a better complexion on the matter when it is stated that we still sell abroad eighteen times as much in value of stationary engines as the Americans do; the totals for 1898 being, for the United Kingdom, £1,454,938, and for America about £80,000. But these figures again may prove as much too reassuring as the percentages were over-depressing. The Americans have not hitherto sought foreign trade in stationary engines. Are they likely to do so in the future?

In order to form some idea of the answer that should be given to this question I made a good many inquiries among those most directly interested in the industry, and received but one reply from all. It may be summarized as follows: "We shall sell our engines where we find the best prices and easiest market. At present that is the United States; but if demand slackens here we shall use the foreign market as an outlet for our surplus product, getting the best prices we can. But we attach the greatest importance to keeping our works in full activity, and shall be prepared to accept low prices abroad in dull times in order to be ready to take advantage of busy times when they come." The attitude of the engine-maker is very much that of the steel-maker, and, indeed, the idea of most manufacturers in the raw and manufactured iron trades appears to be to sell cheaply abroad—at a loss, if need be—and equalize matters by the profits on the home trade. By some inverted process of reasoning, which I have never been able to grasp, this policy is held to be good for the country at large.

The point British manufacturers have to consider, however, is how the prospective competition in America will affect them; not whether it is economically sound, nor how it will affect the American citizen. Will the protective duties of the country enable the manufacturers to carry out their programme? Shall we, in the engineering industry, have a parallel to the sugar trade, with its bounty-fed beet sugar? The answer to this question obviously depends largely on the way in which American workshops are equipped; and here I gladly leave the slippery platform of economics for the surer ground of engineering practice.

Probably the most interesting engine works in America to English engineers are those of the Edward P. Allis Company at Milwaukee in the State of Wisconsin, the firm that has taken the contract for the Glasgow tramway engines. That an American works over 1,000 miles from the nearest seaport on their side of the Atlantic should wrest an order for engines of largest size from our foremost engineering firms in one of the most important centers of engineering activity came as a very big, and very unpleasant, surprise to most of us last summer. The controversy that followed the placing of the order will be within the memory of many, and it is not now proposed to extend it or review the points then brought forward.

I made a special trip to Milwaukee, where the managers of the Allis Company most liberally gave me free access to their shops, with permission to find out everything I could as to the advantages they possessed for enabling them to secure orders in Europe; for the Glasgow engines will be by no means without companions on this side of the Atlantic. In spite of this liberal freedom, I am afraid I can give no specific reason for the success of the firm. In general terms it may be said that the plant is adequate to the big work that is turned out, and that special attention has been paid by a very competent mechanical engineer to the design of large and powerful engines suited to driving electric generators. This has been backed by shrewd and energetic commercial management, and by a bold venture of capital, whenever thoughtful consideration gave promise of good return, that is characteristic of the American business man. The company have been in a fortunate position to take full advantage of the enormous development of electric traction that has occurred in the United States during the last few years. The demand for big engines of this class has sprung up almost at a bound.

Everything in these works is on a big scale; they are laid out for large engines, and practically make hardly any of the smaller type. For instance, they had in hand, for one order alone, at the time of my visit, eight pairs of compound engines, each to indicate 8,000 horse power at best economy, or to be capable of continuously working under a load of 12,000 horse power. These engines, therefore, would be collectively equal to doing the work of 96,000 horses, and I doubt whether such a wholesale order for steam power has ever been taken before. Even our "Powerful" and "Terrible" only work up to 25,000 horse power. The engines are for the elevated railroads of New York and will be placed in a central station there. Another big order, also in progress, was for 11 sets of engines for the electric power station which is to supply current for the surface street railroads of New York. These engines will give an aggregate maximum horse power of 77,000, but their load at best economy will be 4,500 horse power each. It will thus be seen that at the present time New York is putting down for local passenger service by means of electric traction no less than 173,000 horse power, and is getting the engines for all this from a firm in another State over a thousand miles away. These engines are all of the vertical direct coupled type with Reynolds's Corliss gear and run about 75 revolutions per minute, although they may be driven faster. The firm had also on their books orders for 34 blowing engines. These are big engines and weigh from 400 to 650 tons each, and giving off up to 5,000 i.h.p. One was for England, one for France, one for Southern Russia, and five for Nova Scotia, where one of the most complete blast-furnace plants in the world is now being laid down.

Another order in hand was for three engines for electric traction purposes in Cuba. These were interesting as being similar to the engines the firm had supplied, and which are now being erected at the Bankside Station of the City of London Electric Lighting Company. Other engines of equal size were in progress for the Pittsburg electric tramway system, the Richmond (Virginia), the Norfolk (Virginia), and the Lynn (Massachusetts) systems. I am not aware of the size of the last named engines, but the whole of the work in progress represented an aggregate of power that has never been approached in the shops of one firm for engines of this class, and which, I am informed, represented a value of a million pounds.

I have been, since my visit, furnished with a list of the principal engines made by this firm, and a very remarkable list it is. Engines of large size have been shipped to Australia, Tasmania, Austria, Canada, England, Ireland, Scotland, Germany, Mexico, New Zealand, the Sandwich Islands, South Africa, Argentina, Chile and Spain; while others have been sent into 30 different States of the Union and its Territories. Perhaps the most remarkable feature in the list is the number of large engines supplied to the Carnegie Steel Company, there being 31 blowing engines, eight rolling-mill engines, and one air-compressing engine.

The plant of these works is on the scale needed for the operations that have to be performed, the machine tools being mostly, if not all, of American make. Among them may be mentioned a powerful flywheel lathe that would take work 40 feet in diameter and 11 feet between centers. This was served by its own overhead crane, and was driven by an independent engine. There were three large planers together, each of which would take 10 feet square under the bridge, and several large vertical lathes, which would take 10 feet under the heads and 22 feet in diameter. A new one, for which the foundations had just been put in, would take 12 feet in height and turn a diameter of 24 feet. This would be certainly the heaviest tool of the kind I have ever seen. The lifting appliances are very complete. In addition to numerous jib cranes, there are in the shops nine overhead electric traveling cranes, all of high speed. One of these is 50 tons, five are of 30 tons, two of 20 tons, and one is of 10 ten tons capacity. In this way heavy parts can be carried over all other work in progress, and cleared out of the way without interruption. It is a point of which the value is generally recognized in America, and which British engineers might more often consider. The shops cover an area of 22 acres. Another factory has recently been acquired in Buffalo in order to relieve the Milwaukee establishment. A point I noticed in these works was the nearness to finished size of the forgings used. There was really very little metal to be removed beyond that required to make a proper finish. I think, however, the Americans forge closer to size than is usual in Europe. The hours of work here are from 7 to 12 and from 1 to 6, or ten hours. As is usual in America, there is no wasteful break for breakfast, a system to which British workshops will have to come sooner or later. When men come in at 6, the time spent before breakfast is more or less wasted; in a good many shops it may be said to be entirely wasted. Whatever the hours may be, whether nine, as in Great Britain, or ten, as in America, the 6 o'clock rule with a break for breakfast is bad. The night shift at Messrs. Allis' work from 6 P. M. until midnight and from 1 A. M. till 7 A. M., or 12 hours' work, for which, however, they receive 13 hours' pay. For the most part the men are paid day wages, and not by the piece.

I will conclude the notice of these works with an incident illustrative of the boldness with which Americans attack engineering problems. In 1889 Messrs. Allis supplied the Boston Street Railway Company with nine engines of 1,000 horse power each for actuating electric generators. These were to drive the dynamos by means of belts in the way considered best at that period. By the year 1894 it had been found that direct driving, i. e., without belt-gearing, was the better way; so, though the machinery was but five years old, the whole station was remodeled at a cost of £100,000, new generators being provided, and the engines altered for direct driving. I am afraid we in England should have looked on it as little less than criminal to throw away beautiful new machinery almost before it had begun to be worn out. As a matter of fact, I am informed, the saving effected has quite justified the outlay, showing, indeed, a very substantial profit.

Other important engine works I visited when in this part of America were those of Messrs. Fraser & Chalmers, in Chicago. This establishment I was more anxious to see, as the firm have within the last few years started a large factory at Erith, in Kent. The latter works were erected with a view to getting the advantage of cheaper labor in England, and, therefore, as it was supposed, a lower cost of production. I had heard this expectation had not been fulfilled, and I thought, perhaps, I could find the reason. The subject, however, was one upon which the Chicago branch did not wish to express an opinion, very naturally, perhaps; but I found that it is considered that American makers of this class of machinery have an advantage, first, in cheaper labor, i. e., cheaper in terms of product, not in time rate; secondly, in a better quality of iron; and, thirdly, in American designs using less metal. The mining machinery made by this firm is largely for new countries, where transport is difficult; the latter feature, therefore, is of importance. The Chicago firm have also a lower rate of railway carriage, although, as they are 1,000 miles from the sea, that can hardly be a ruling factor for export orders. They further attribute a good deal of their success to the readiness with which they pull old tools out and replace them by new ones as soon as occasion arises. On visiting the works on the outskirts of Chicago, I found them most admirably arranged, the lifting appliances, in the shape of electric cranes and pneumatic hoists, being especially well devised. The latter are worthy of attention, as they save a great deal of labor. Throughout the shops there are fitted a series of overhead single rails, suspended at a convenient height above the machine tools. Hanging from these rails are long cylinders having pistons, the piston rods ending in hooks. One of these lifting cylinders is brought over the piece to be transported, the hook is attached to slings, air at pressure is admitted beneath the piston, and the whole is then lifted and can be run along the overhead lines to any point within the scope of the apparatus. The system, though not novel, is extremely simple, and the saving in labor, not only in transporting work, but also in setting it in the tools, is considerable. A few of our best equipped works have these lifts, but they ought to be more universal.

These works were among the best organized of any I visited in America, and are full of valuable suggestions to the managers of engineering shops. The machinery produced is also interesting not only as being mechanically ingenious, but from its destination and use. There were in progress complete plants for extracting the more costly metals, from gold and silver, to copper, lead and tin. The four corners of the earth are brought together in the Chicago shops, more especially the new corners. There were in hand mining plants for Alaska, Honolulu, Honduras, British Columbia, Tasmania, Australia, New Zealand, the Straits Settlements, India, Cape Colony, and Canada. It was evident from the work going forward here that trade in mining machinery does not always follow the flag.

The hours of work are ten a day, from 7 to 12 and 1 to 6. Saturday work closes at 4 o'clock, so that 58 hours a week are made. The shops are kept going day and night and no difficulty is found in regard to transferring work from the day shift to the night shift. The foremen, between them, can be depended upon to keep matters straight in this respect. Piecework is not usual, day wages being generally paid, but such operations as can be done on the piece system are so carried out. This firm has doubled the magnitude of its operations during the last five years.

Another large engine factory I visited was that of the Lane & Bodley Company at Cincinnati. I had seen some large engines by this company at work and was desirous of visiting the factory that could produce such fine examples of engineering as they were, more especially as I was told that I should find an example of an "old-fashioned firm"—something, my informant said, that would make me think I was at home. From the latter point of view my visit was a failure. I found the firm, which has been established in Cincinnati for 65 years, on the point of moving to quite new works

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* This series of articles on American Industries was written by an expert of The London Times, who made an extensive trip through this country in order to prepare the articles, the first of the series being published in the SUPPLEMENT of July 21.

outside the town. There they have constructed a factory, the principal building of which is 800 feet long by 500 feet wide, and, to judge by the architect's drawings, it is a very handsome edifice. In the design and laying out of the new shops the management have incorporated the result of their own experience and that of any other person they could get hold of. It is a great source of strength to the American manufacturer that he will adopt other people's ideas readily if he finds them better than his own. These new shops are to be, therefore, models of everything most advanced and most desirable. I saw the parts of one machine that had just been completed in the old shops for the equipment of the new. It is worth mentioning, as it will help engineers to size the operations to be conducted. It was a planing machine, 112 feet long, that would operate on a piece of work 16 feet by 16 feet in cross section, and would take a cut 56 feet long, that being the length of the table. The 112 foot bed was in ten massive castings, and contained the enormous diagonal screw that moved the table. A description of this enormous machine tool would appear somewhat technical to ordinary readers, but they may safely assume that with such an example (together with the heavy tools for European purchasers made by the Niles Tool Works, presently to be described) it is idle to say that facilities for an opposition to our marine engineering industry do not exist in America.

The business of the E. P. Allis Company at Milwaukee also shows that steam engines of the very largest size can be purchased in America, and are, moreover, shipped across the Atlantic in competition with European firms. It is true these are not marine engines—the design is different; but it would be only a small matter to import from the Clyde or Tyne draughtsmen competent to furnish all the detailed work and foremen to superintend its production, while practically all the plant needed for manufacture already exists. There are, it must be remembered, many other engineering shops besides those I have mentioned which make big engines of what may fairly be called the marine type, although they are used for land purposes. This should be said in justice to other firms, but it is unnecessary to give a list of names, the general plan of these articles being to deal with works visited. In regard to shipbuilding, there is in America some of the most advanced practice in the construction of steel hulls that I have seen anywhere. At present we have felt no pinch of foreign competition in the shipbuilding and marine engineering industry, although Germany now possesses the premier position in regard to speed, and has built and owns three out of the four largest Atlantic liners. It is not, however, toward Germany that we need look with most anxious eyes, but to America, the land of enterprise and the home of cheap steel.

MECHANICAL STOKING.

II. THE RONEY MECHANICAL STOKER.

THE great increase that has taken place of late years in the size of steam plants has made mechanical stoking almost an absolute necessity if high economy is to be achieved. Fuel and labor are two of the chief items in the operating expenses of manufacturing enterprises, and mechanical stokers effect most important economies under both these heads. The Roney mechanical stoker was invented in 1885 by Mr. William R. Roney, and while it still retains the main principles originally introduced by the inventor, the improvements made in the last fifteen years, both by himself and Mr. W. W. Churchill, mechanical engineer for Westinghouse, Church, Kerr & Company, have greatly increased its efficiency and durability.

The improved Roney mechanical stoker is to-day in great demand, particularly for large aggregations of steam power, such as are found at the large central stations for electric lighting and electric traction. They have been ordered by the Manhattan Railway Company, of New York, for 34,000 horse power of boilers; by the Third Avenue Railroad Company for 32,000 horse power, making an aggregate of 66,000 horse power of boilers which will be operated by mechanical stokers among the traction companies of New York city alone. The makers, moreover, have recently received orders for equipping boiler plants of an aggregate of over 225,000 horse power in various parts of the United States. The construction and operation of the Roney stoker is clearly shown in the accompanying illustrations.

Fig. 1 shows a general perspective view of the stoker in operation, while the details of its construction are shown in Figs. 2, 4, and 5. The mechanism is usually driven by a small engine or motor placed at one end of the battery of boilers, and connected to the shafting by means of a housed worm, running in oil. Such a motor is shown connected to a battery of boilers in illustration Fig. 6, the plant being the 2,000 horse power of boilers of the Baltimore Electric Refining Company, of Baltimore.

The mechanism of the stoker consists of a hopper for receiving the coal and a set of rocking, stepped, grate bars, inclined at an angle of about thirty-seven degrees to the horizontal, and a dumping grate at the bottom of the incline for the discharge of ashes and clinkers, as shown in Fig. 2. The coal is fed on to the inclined grate from the hopper by a reciprocating pusher, Fig. 4, which extends almost the entire width of the furnace, and is operated by an agitator sector, the agitator having a constant amplitude of movement, while the agitator sector, which is connected to the hopper shafting, has its motion controlled by an adjustable hand-wheel and receives its motion from the agitator. Hence, the range of motion of the pusher is from no stroke to full stroke, independent of the rotation of the shaft or the movement of the grates; the amount of coal pushed into the furnace being, therefore, easily adjusted to suit the kind of fuel employed and the demand for steam. The motion of the grate bars is similarly regulated and controlled, so that for low grade coals increased motion may be had in order to burn a sufficient quantity of coal per square foot of grate.

The Roney mechanical stoker is unique in having the grate bars run across the furnace at right angles to the incline. The movement of the grate bars, it will be seen, breaks the fire in lines at right angles to the line upon which gravity is acting; hence, the constant tendency of the movement of the bars is to break the fire crossways to its line of motion toward the back of the furnace, while the action of gravity is to keep the broken particles of the fire in close contact, preventing any large excess of air and securing high economy of fuel. The rocking motion of the grate bars constantly works the ash toward the back of the furnace, where it is discharged by the dumping grate into the ashpit. By referring to Fig. 1, it will be noticed that by opening the ashpit doors in the furnace front, the fireman, as the result of the steeply inclined position of the grate, is enabled to look directly at any part of the grate, the entire bed of the fire being visible from the under side. Hence, clinkers can be seen as they form, and dislodged without admitting cold air above the furnace. The fire in a furnace of this kind can be cleaned in less than one minute, thus avoiding the loss of steam pressure common to hand-fired furnaces when cleaning fires.

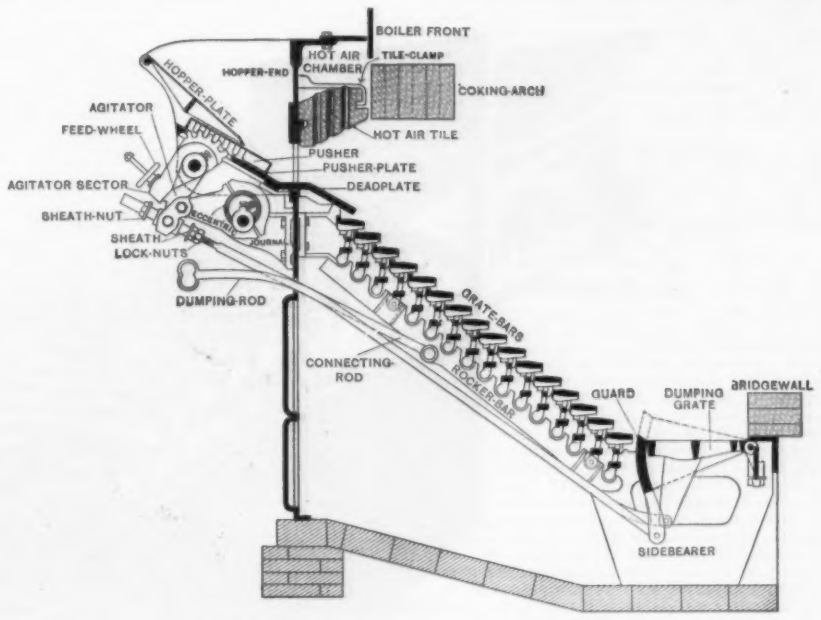


FIG. 2.—DETAILS OF CONSTRUCTION.

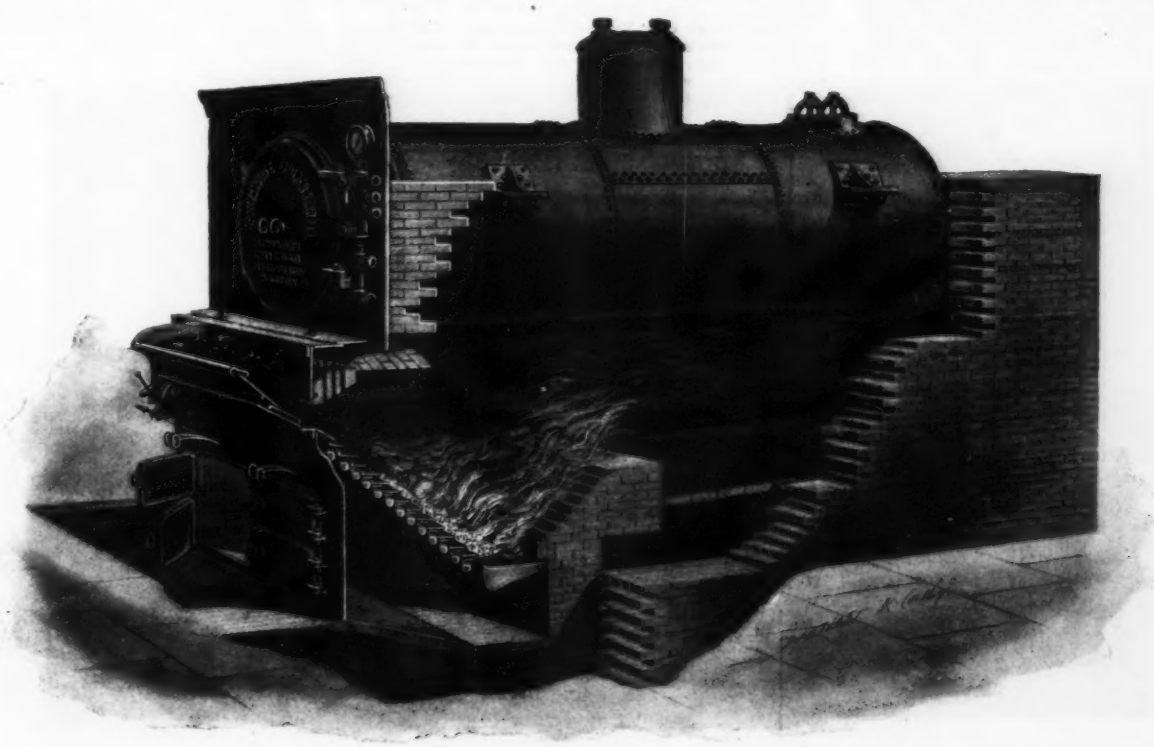


FIG. 1.—GENERAL PERSPECTIVE OF THE RONEY MECHANICAL STOKER APPLIED TO A HORIZONTAL, TUBULAR BOILER.

During the early stages of the development of the Roney stoker, the grate bars were cast in one piece, and when the fuel plate or top burned, it was necessary to discard the entire bar. Later the tops and webs were made separately and only the top was discarded. This improvement, combined with the fluting of the under side of the fuel plate, gives them a large amount of cooling surface and considerably reduces the cost of repairs.

When anthracite coal is burned, the stoker is pro-

vided with guards attached to the dumping grates to prevent fire slipping off brake into the ashpit when the fires are being cleaned. By this arrangement either anthracite or bituminous coal may be burned at will without making any change of grates. This form is an efficient hard coal stoker, and is being successfully used only where anthracite coal is available. It is estimated that in combination with a modern system of coal handling by machinery, such as is installed in all large modern steam plants, the Roney stoker reduces the cost of firing the boilers to one-third, and in very large plants to one-fifth of cost for hand-firing, while

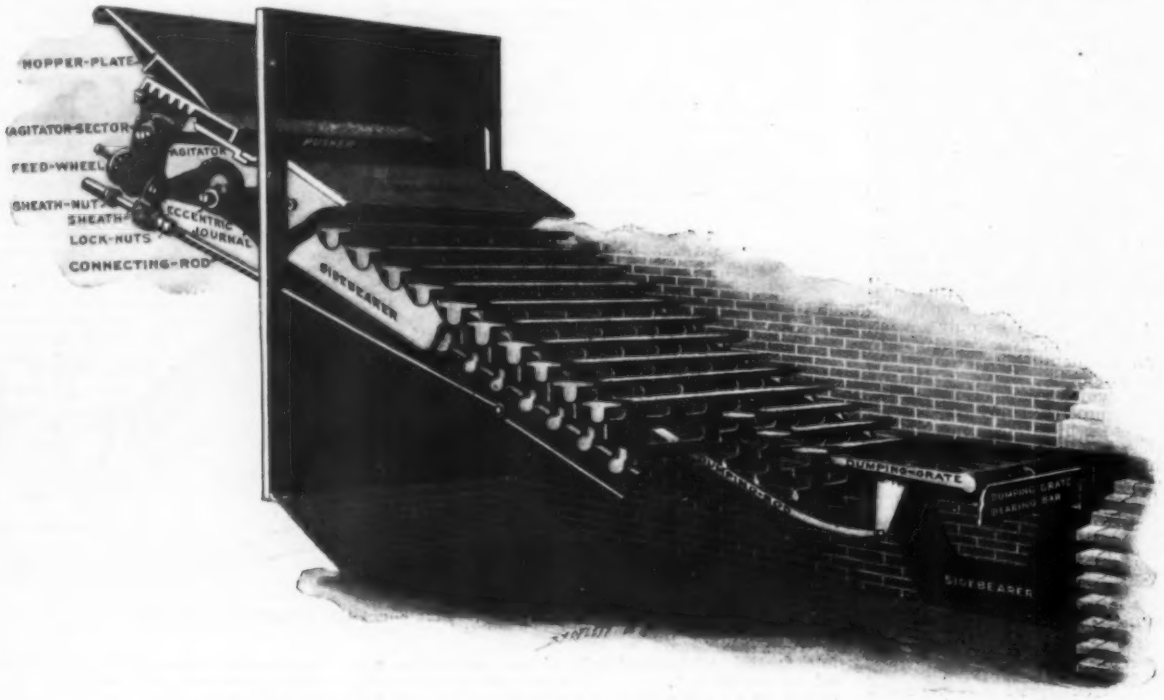


FIG. 3.—SECTIONAL PERSPECTIVE OF RONEY MECHANICAL STOKER.

the saving in fuel will, of course, assist in paying the cost of the installation.

An important factor of this system is that it conduces to the smokeless combustion of bituminous coal, a very important consideration in these days, when large municipalities are forbidding the use of bituminous coal on account of the smoke nuisance. The methods adopted for the consumption of smoke are as follows: A coking arch of firebrick (see Figs. 1 and 2) is sprung across the furnace, covering the upper part of the grate and forming a reverberatory furnace and gas producer, whose action is to coke the coal as it is pushed forward into the furnace and release its gases. These, mingling with the heated air supplied in small streams through the perforated tile above the bedplate (see Figs. 1 and 2), are quickly burned in the large combustion chamber above the bedding of incandescent coke on the lower part of the grate. This method of supplying coal at the front and coolest portion of the furnace presents conditions most favorable for complete and economical combustion. There is a sufficient air supply through mingling of the air with the volatile gases, a constant high temperature, and a uniform supply of fuel, regulated as desired.

In a town in Iowa a gang of striking railroad construction employés became so riotous that it was necessary to arrest them all, and the jail being too small to accommodate them, they were incarcerated in box cars.

RAILWAYS IN SPAIN.

ON January 1, 1899, there were 12,984 kilometers (8,068 miles) of railways in the kingdom of Spain, of which 11,611 kilometers (6,842 miles) were of the standard gage—1·67 meters (5 feet 6 inches); 1,965 kilometers (1,221 miles) were of various narrow gages from 60 centimeters to 1 meter (24·6 to 39·37 inches); and there was one "cremallera" or cog-wheel road of 8 meters (5 miles).

The principal railway corporations are:

1. The Northern Railway Company of Spain, having 3,684 kilometers (2,289 miles), equipped with 662 locomotives, 36 saloon cars, 366 first-class cars, 400 second-class cars, 897 third-class cars, 192 miscellaneous cars, 566 baggage cars, 9,545 box and crate cars for merchandise and cattle, and 2,734 open or platform cars, making a total of 14,726.

2. The Madrid-Zaragoza-Alicante Railways Company, having 3,665 kilometers (2,277 miles), equipped with 392 locomotives, 31 saloon cars, 187 first-class cars, 179 second-class cars, 464 third-class cars, 102 miscellaneous cars, 340 baggage cars, 3,497 box and crate cars for merchandise and cattle, and 3,952 open or platform cars, making a total of 8 752 cars:

3. The Andalusian Railways Company, having 1,108 kilometers (688 miles), equipped with 147 locomotives, 145 saloon cars, 78 first-class cars, 105 second-class cars, 256 third-class cars, 32 miscellaneous cars, 126 baggage cars, 1,082 box and crate cars for merchandise and cattle, and 1,830 open or platform cars, making a total of 3,654 cars.

4. The Tarragona, Barcelona and France Railways Companies, operated by the Madrid-Zaragoza-Alicante Company as the Catalan division, equipped with 154 locomotives, 15 saloon cars, 70 first-class cars, 132 second-class cars, 269 third-class cars, 34 miscellaneous cars, 75 baggage cars, 3,422 box and crate cars for merchandise and cattle, and 147 open or platform cars, making a total of 4,149 cars.

The four systems above named had 1,235 locomotives out of a total of 1,835, and 31,296 cars out of a total of 40,197; the balance (480 locomotives and 8,901 cars) was divided among fifty smaller roads.

All standard (5 feet 6 inches) railways diverge from Madrid, either directly or by continuations from junctions on the main lines, and all railways are invariably measured in a direction from Madrid.

There were forty-one lines devoted to carrying ores, coal, and minerals, which do not carry passengers.

From the mountainous character of the country and the consequent expense of construction, railway development in Spain has been slow. The government, however, has been very liberal in subsidies to the larger lines, nineteen companies having received the equivalent of about $64,000,000. The principal subsidies were given to the Northern Railway (about $31,000,000), to the Madrid-Zaragoza-Alicante (about $11,000,000), the Southern Railway ($6,000,000, this being the largest subsidy per mile of any road in Spain), the Medina del Campo Railway (about $5,600,000), the balance, from a few thousand dollars up to some $2,600,000, being divided among numerous small roads.

Madrid, as the center of this railway system, is situated at an elevation of only 655 meters (about 2,149 feet) above the level of the sea; but the mountain heights between Madrid and the seaports impose steep grades, and in many places long detours have had to be made, all of which, with a gage of 5 feet 6 inches and the consequent friction, makes operation of the roads very expensive and the rates of transportation very high. The tunnels are numerous, some being large, and the bridge work in many places is upon an expensive scale.

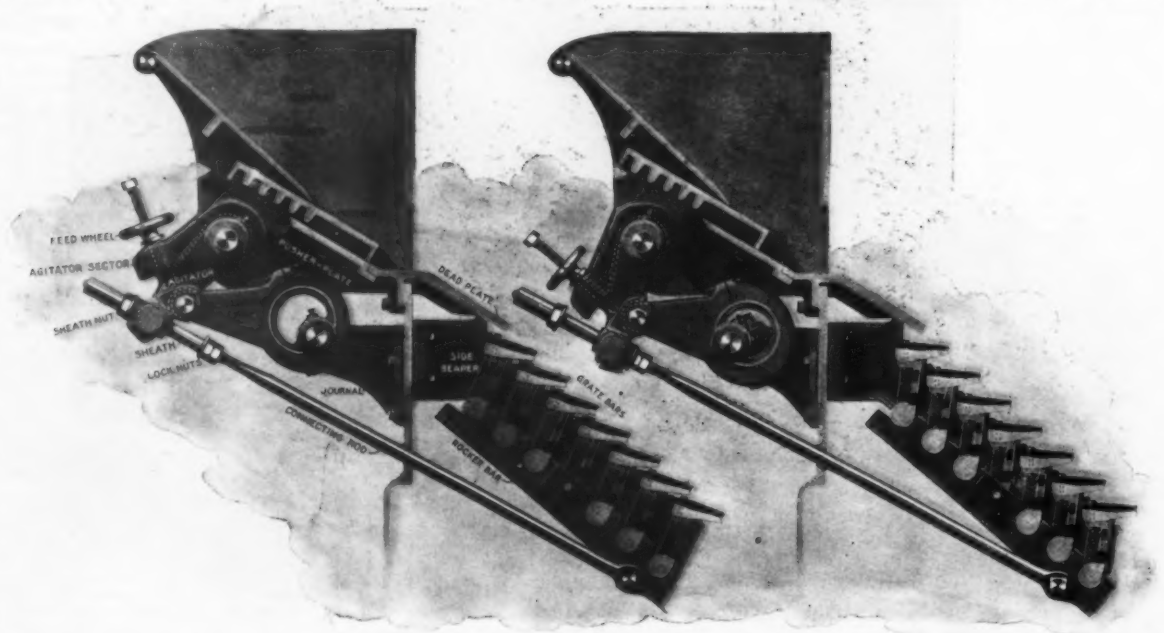


FIG. 4.—FEED AND GRATE MOVEMENT, SHOWING GRATE IN THE INCLINED AND STEPPED POSITIONS.

The principal seaports are distant from Madrid, viz.: Barcelona, 685 kilometers (425⅝ miles); Malaga, 635 kilometers (394⅛ miles); Bilbao, 551 kilometers (342⅜ miles); Cartagena, 525 kilometers (316¼ miles); Santander, 508 kilometers (312⅛ miles); Valencia, 490 kilometers (304½ miles); and Alicante, 455 kilometers (282¾ miles).

It will be observed that were it not for the mountain ranges intervening, the average grades from these seaports to Madrid would be very slight.

There are many concessions held from the government for projected lines and branch lines which remain without even a commencement of work, owing to the evident expense of the construction.

During the year 1899 there were eleven lines of 5-foot 6-inch gage in construction, and about 497 miles more under concession; there were 1,036 kilometers (about 643¾ miles) of narrow gage authorized, and twenty-one lines in construction; there were 1,593 kilometers (981 miles) of 5 foot 6-inch gage and 802 kilometers (498·34 miles) of narrow-gage railways recorded either as

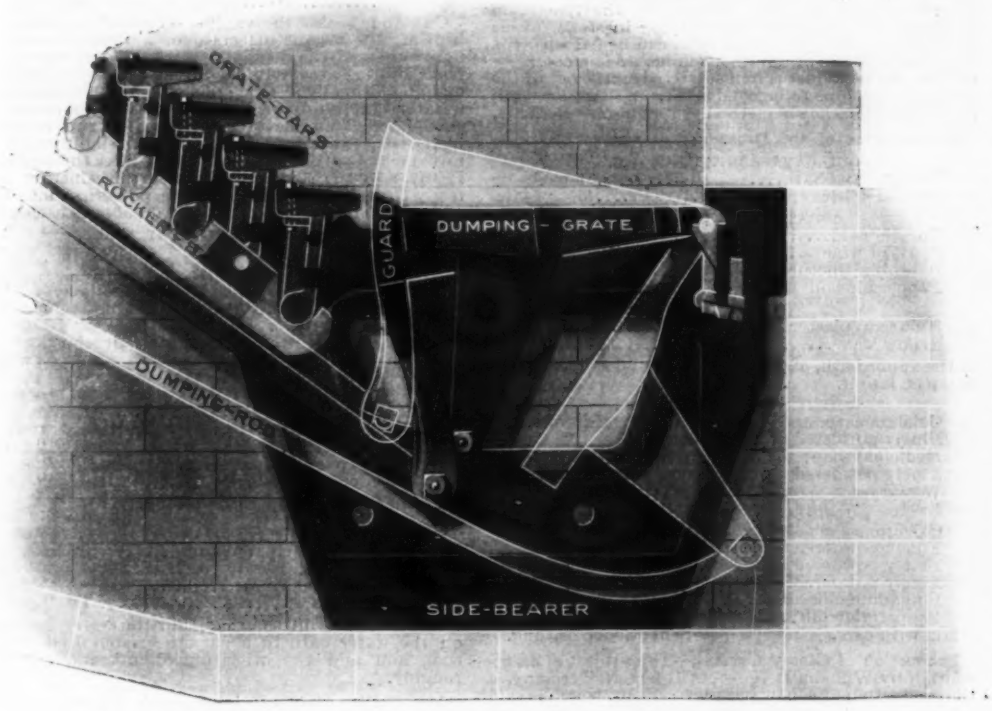


FIG. 5.—DETAILS OF DUMPING GRATE AND GUARD.

paralyzed or as not having commenced work of construction.

It is estimated, official figures not being obtainable at present, that in 1899 there were only 63 kilometers (39·14 miles) of 5-foot 6-inch gage railway and 116 kilometers (72·08 miles) of narrow-gage railway opened for operation, making a total of, say, 111 miles.

Numerous new concessions have been granted for construction of narrow-gage railways in the iron-ore districts and coal regions. Those in the iron-ore districts are in general given to private companies; those in the coal regions are given to both private companies and to individuals who seek to sell to promoters or incorporators, and it is said that the exorbitant price of coal is an inducement for investors, who are readily taking up such operations. Continental and English and Scotch ironmasters and capitalists have in the last few years bought extensively of iron-ore and coal properties in Spain and are expending large sums of money in railways to transport the products to the main lines or to the seacoast.

It is confidently predicted that the exports of iron ore in 1900 will reach 10,000,000 tons, or 2,000,000 tons in excess of 1889; and the production of coal for consumption in the country, stimulated by the very high prices of foreign coal, is increasing at a rapid rate.

Such are some of the factors in the consideration of railway development in Spain, which in the future, it would appear, must be in the narrow gages; and if the government protects such operations from illiberal exactions, these will increase rapidly, with enormous benefits to the country and handsome returns to the proprietors.

Geologically, Spain is perhaps as rich in its metallic and mineral stores as any country in the world according to its area, and these can be utilized only by affording transportation by railways. Chief among such resources may be mentioned antimony in ten districts, anthracite in five districts, arsenic in five districts, asphalt in three districts, mercury in nine districts, sulphur in eight districts; copper, cobalt, and nickel in twenty-eight districts; iron ore in thirty districts, coal in nine districts. And there are lignites and manganese mines, and marble quarries yielding the finest qualities and some of the most beautiful colors, which may be seen in many churches and public buildings. Cupreous and iron pyrites exist in enormous quantities. Silver and silver lead are important. Zinc is abundant, and wolframite, a metal now in demand at high prices in the manufacture of Bessemer and open-hearth steel for special purposes, exists in four districts.

The laws governing the construction and operation of railways are perhaps quite as fair in their apparent intent and purpose as in any Continental country; but the execution of the laws and the supervision of railways of industrial character might be modified.

I wished to embody in this report reliable information as to the character of the locomotive power, cars, and appurtenances; as to their construction, relative dead weights and carrying capacity, fuel consumption, wages of employés, etc., but official information is not obtainable at this time.

The speed of passenger express trains on the main lines is officially announced at from 23¾ to 27 miles per hour, the latter being the speed of the "Sud Express" between Madrid and Hendaya over the Northern Railway; the next service approaching this speed is that between Valencia and Tarragona, which is 26½ miles per hour.

The passenger rates are high; the first-class fare, for instance, from Madrid to Hendaya, a distance of 393½ miles, is the equivalent of $14.05, or about 3·6 cents per mile; and the extra charge for the Sud Express ticket is 33⅓ per cent. in addition to the first-class ticket. The second-class fare for the same service is the equivalent of $10.66, and the third-class $6.23, approximating, respectively, 2¾ and 1⅝ cents per mile. While some roads have higher fares per mile, those given are the average on the most important lines in Spain.

Transportation rates on iron ore, which information is of interest to Americans, may be stated, without details, for various roads, at an average of about 2·4 to 2·5 cents per ton per mile. These rates are only to the official terminal city or town station; where tracks are extended to the port, there are additional charges for cars to be sent to the port, or, in case no track goes to the port, the material must be carted at the owner's expense.

Except at Bilbao, Huelva, and one or two other places, the railway companies have nothing of what we know as facilities for shipment from cars to vessels. It is just to say, however, that such improvements are contemplated at other ports, and it is hoped will soon materialize.

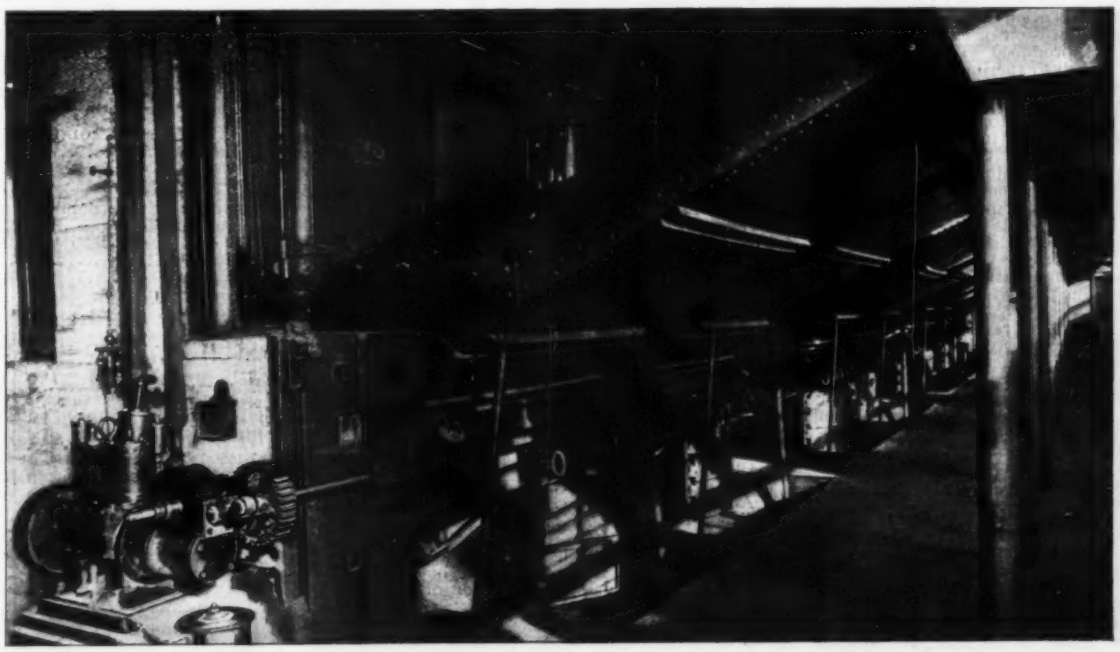


FIG. 6.—TWO THOUSAND HORSE POWER OF BOILERS EQUIPPED WITH RONEY MECHANICAL STOKERS.

CONTEMPORARY ELECTRICAL SCIENCE.*

CHANGE OF RESISTANCE BY MAGNETIZATION.—The influence of magnetization upon the resistance of a wire has not yet been studied with the care which the importance of the subject demands. Electromagnetic theory cannot but be greatly affected by any facts which are elicited, and the influence of changes in the earth's magnetic field upon magnetic conductors may be of some practical interest. Results attained in the case of bismuth would seem to indicate that there is no connection between magnetization and change of resistance. But A. Gray and E. Taylor Jones have been led to the opposite conclusion by the results of some experiments on soft iron wires. They determined simultaneous values of the magnetizing force, the magnetization, and the resistance. To equalize the heating effects, they wound two identical lengths of the same wire on the same core, one longitudinally and the other transversely, and inserted the compound coil in the interior of a magnetizing coil. The transverse coil was, of course, only very feebly magnetized. Both wires were traversed by the same current, but the longitudinal coil always showed the greater increase of resistance, the difference between the two fractional increments being about 3×10^{-4} in a field of 30 units, and 15×10^{-4} in a field of 300 units. The change of resistance appears to be proportional to the fourth power of the intensity of magnetization.—Gray and Jones, Proc. Roy. Soc., June 21, 1900.

ELECTRIC PROPERTIES OF DIFFERENT GLASSES.—A. Gray and J. J. Dobbie have continued their researches on the effect of chemical composition upon the electrical properties of glass. That this effect can be very great is shown by a single case, in which the resistance of a lead-potash glass was reduced 130 times by substituting soda for the potash. Barium glasses have very peculiar properties. A glass manufactured by Schott, of Jena, and composed mainly of barium oxide and alumina in combination with silica and boron trioxide, has a very high resistance, one quite unmeasurable, indeed, within the range of temperatures commanded by the authors. Moreover, the inductive capacity in a plate of this glass is exceedingly low, and the glass shows little or no effects of dielectric polarization. The authors thought that the barium might be the determining factor in the high resistance. But a barium-potash glass made by Powell & Sons showed comparatively a very low resistance, which is exceeded even by ordinary commercial lead glass. The effect of annealing glass is greatly to increase the resistance, often to three times its original value. An annealed lead potash glass containing 48 per cent. of silica and 41 per cent. of lead oxide had a specific re-

* Compiled by E. E. Fournier d'Albe for The Electrician.

sistance of over $29,000 \times 10^{10}$ ohms at 140°, and a dielectric constant of 7·42. The resistances were studied by the method of flasks filled with mercury.—Gray and Dobbie, Proc. Roy. Soc., June 21, 1900.

IONIC CONDUCTIVITY OF THE ATMOSPHERE.—Lenard's remarkable discovery that ultra-violet light is capable of imparting conductivity to a non-conducting gas is utilized by J. Elster and H. Geitel to account for the dissipation of the charge of an electroscope by ordinary air. Since the sun's rays contain ultra-violet light before they impinge upon the atmosphere this light must ionize the upper strata, and the ions produced will be gradually distributed through the whole of the atmosphere by diffusion and convection. Hence the air will contain stray ions of both signs, possibly differing in frequency with the altitude. It is these ions which gradually discharge a carefully insulated electroscope. This view is corroborated by the observation that a limited volume of air can be deprived of its conductivity by electrostatic force, all the ions being attracted to the surface of the body charged with the opposite kind of electricity and there discharged. This process is the quicker, the smaller the volume of air thus treated, i. e., the smaller the number of stray ions. Particles of dust, smoke, or fog produce a retardation of discharge instead of an acceleration. On the summit of high mountains there is a more rapid discharge of negative than of positive electricity, probably owing to the retention of a large proportion of the positive ions in the higher strata.—Elster and Geitel, Ann. der Physik, No. 7, 1900.

POINT DISCHARGES.—E. Warburg has brought out the differences between positive and negative ionization by keeping a point at a constant potential face to face with a large plate connected to earth, and arranging the supply from an influence machine in such a manner that the glow was confined to the immediate neighborhood of the point. On employing very carefully purified nitrogen as a medium, he found that the current intensity obtained by charging the point to —3,310 volts was 200 times as great as that obtained with +5,180 volts. This enormous difference was reduced to a ratio of 4 : 1 by a slight admixture of oxygen. If we assume, with Thomson, that ionization consists in splitting the atom into two parts, one of which, the negative ion, is very small and has a great velocity, while the other is much larger and slower, it may easily happen that the negative nitrogen ions are considerably retarded by combining with stray oxygen atoms, while the positive ions would be much less affected in comparison. This is the author's idea of the effect of an admixture of oxygen as an impurity. In the transition from the brush to the glow discharge, the author noticed a sudden decrease of the potential gradient near a positively charged point, but not near a negatively charged point. He attributes this to greater ionic density in the former case.—E. Warburg, Ann. der Physik, No. 6, 1900.

ABSORPTION AND IONIZATION.—Lenard showed, in 1894, that cathode rays are absorbed by a gas in exact proportion to its density. Since the energy is probably all spent in ionizing the gas, it should follow that the ionization is also proportional to the density. This has been verified by J. C. McLennan. He found an agreement between the ionization in hydrogen at atmospheric pressure and that in air at a pressure of 53 mm. At these pressures the two gases had the same density, and in both cases, therefore, according to Lenard's absorption law, the disposition of the rays, their actual intensities, and the amount of them absorbed from point to point in the ionizing chamber were precisely the same. Under these conditions the equal ionizations obtained not only form a strong confirmation of Lenard's absorption law, but they also show that where equal absorption of cathode rays occurs, equal ionization is produced. In order to test the conclusion more closely, experiments were made with air, hydrogen, carbon dioxide, oxygen, nitrogen, and nitrous oxide, and in all cases it was found that, when these gases were reduced to the same density, the same ionization was produced in them by rays of constant intensity. It follows, therefore, that an ionization law exists exactly analogous to that of absorption—namely, that when cathode rays of a given strength pass through a gas, the number of ions produced per second on 1 c. c. depends only upon the density of the gas, and is independent of its chemical composition. From the results thus obtained, the author concludes that, when cathode rays are absorbed to any extent, the positive and negative ions produced by these absorbed rays are of a definite amount which bears a constant ratio to the quantity of the rays absorbed; that is to say, in order to ascertain the relative ionizations produced in any two gases by cathode rays of the same intensity, it is sufficient to determine the absorbing powers of the two gases for the same rays. In other words, the coefficients of ionization are determined when the coefficients of absorption for the same gases are known. The author then deals with the ionization in any particular gas under varying pressures. The inference is drawn that, under rays of constant intensity, the ionization in a particular gas varies directly with the pressure.—J. C. McLennan, Proc. Roy. Soc., Abstract July 9, 1900.

Double Sheet Metals, Electrolytically Produced.—While the metal precipitated electrolytically from baths is very pure, but also quite brittle, and only obtains toughness by remelting or rolling, a metal which may be worked without any preparation can be produced and the evaporated sheet metal may even be covered with another metal, which admits, for instance, of producing silver-plated sheet copper very cheaply. H. Becker precipitates a thin layer of silver on a highly polished silvered copper plate, rubbed with flowers of sulphur until of golden color, running in highly diluted nitric acid and hanging the plate with the silver layer in a copper bath. With a correct density of current and sufficient movement of the solution a pliant silvered sheet copper is obtained, which exposes the highly lustrous side and can be readily taken off. Becker asserts that his process may also be utilized for other metals.—Mittheilungen des Vereins deutscher Kupferschmiede.

TRADE NOTES AND RECEIPTS.

Production of Peat Briquettes.—For the manufacture of peat briquettes the crude, wet peat is broken up by squeezing and freed by means of a sifting arrangement from its admixtures, such as fibers, roots, etc. The mass thus cleaned is next heated by means of direct heating gases or steam. This is best accomplished by rotating cylinders fitted with transporters in the interior.

The heated peat substance is then conveyed into large receptacles, in which it is subjected to a strong pressure by means of machinal contrivances, and thus dehydrated. The dehydrated peat mass is again disintegrated, and for the removal of the remaining moisture is best made to finish drying in steam ovens with tiers, because the steam oven can be fed with the dead steam of the briquette machine. After complete drying, the peat dust is immediately transferred to the briquette machine to be condensed and shaped according to the well-known method.—Technische Berichte.

Prescriptions of the Dresdener Apotheker Verein.—

QUILLAYA BARK TINCTURE.

Cut quillaya bark	1 part.
Diluted spirit of wine	5 "

BORATED MOUTH WASH.

Boracic acid	5 parts.
Spirit of wine	120 "
Ratanhia tincture	15 "
Peppermint oil	10 drops.

CORN CURE.

Melt soap plaster	85 parts.
Yellow wax	5 "

in the vapor bath, and stir finely ground salicylic acid, 10 parts, into it.

JENKIN'S TOOTH POWDER.

Calcium carbonate	30	grammes.
Finely powdered orris root	15	"
Medicinal soap	7·5	"
Finely powdered pumice stone	7·5	"
Wintergreen oil	8	drops. Mix.

PULSINELLI'S TOOTH POWDER.

Calcium carbonate	25	grammes.
Finely powdered sepia shells	5	"
Finely powdered orris root	5	"
Finely powdered myrrh	2·5	"
Potassium chlorate	12·5	"
Peppermint oil	6	drops.

Mix with care. —Seifensieder Zeitung.

Production of Glossy Cement.—The subject of an invention by Wilhelm Borgolte, of Hoexterf, Germany, is the production of a new peculiar cement, which is said to excel Portland cement, not only in being much more resistive to atmospheric carbonic acid and moisture, but also in forming an extremely hard mass with mirror-like luster upon setting. The product prepared according to the process described below adheres, mixed with water, in a superior manner and possesses a certain resistance to diluted acids. For the building trades it is of importance that the new cement has the property of accepting in a freshly set state, without special preparation, durable oil paint and other coating.

The process consists in first burning the raw materials suitable for the manufacture of cement singly with difficultly decomposable hydrocarbons and exclusion of air, before the production of the raw mixture of the cement. The substances thus treated, which have a black or dark gray appearance owing to embedded graphite, are powdered and in the requisite mixing proportions burnt once more with addition of oil and powdered coal and exclusion of air.

It has been proposed before to mix and burn cement with hydrocarbons, but the novelty and peculiarity of the present method consist in the burning with exclusion of air, as well as in that the materials, converted by the first burning process, are burned again, and act upon each other at the second baking, so that a product with new chemical and physical properties results. While a cement which has been burned only once, with admixture of hydrocarbons and exclusions of air, shows rust like brown spots upon continued storing in damp air, same do not appear if the raw material has singly been subjected to the above described pre-burning. By the first baking of the raw materials a material change sets in, so that ferric oxide is reduced and lime does no longer slake in water with calefaction. The second burning causes the real formation of cement.

In carrying out the process, the raw materials to be burned are separately reduced to powder and singly mixed with two percentum by weight of difficultly decomposable hydrocarbons. The various mixtures are, after addition of water, shaped into bricks, which are baked with exclusion of air, as far as possible, after drying. The burnt product is reduced and ground like the Portland cement clinkers.

It has been established by trials that the raw materials thus burned and ground furnished an especially good gloss-cement, for instance, in the following:

Limestone	2 parts	by weight.
Clay	1 "	" "
Clayey marl	1 "	" "
Argillaceous earth	1 "	" "
Ground coal	1 "	" "

To the intimate mixture of the above ingredients, the raw powder proper, another 2 per cent. of liquid hydrocarbons is added. After the whole has been homogenized into a stiff mass with addition of water, like in the manufacture of Portland cement, it is shaped into bricks, which, after drying, are burned with exclusion of air contrary to the practice pursued in the manufacture of Portland cement. The burnt product is further treated like Portland cement. If other raw materials are employed, the raw mixture should be altered accordingly.

The lustrous cement thus obtained is mixed with unburnt materials according to the purpose it is to be used for. The following mixing ratio has been found valuable for casting and stamping purposes:

Gloss cement	2 parts.
Crude clay, powdered	2 "
Clayey marl, powdered	1 "
Sandstone, powdered	1 "
Micaceous slate-marl, powdered	1 "
Variegated sandstone, powdered	2 "
Sand-coal cinders	2 "

—Neueste Erfindungen und Erfahrungen.

SELECTED FORMULÆ.

Flavoring Extract of Vanilla.—The only way to make a cheap flavoring extract of vanilla is to reduce the strength of a strong preparation, employ inferior material, or strengthen a weak extract with tonka, or use a solution of vanilline. We give several formulas, but do not believe in preparations which are to be sold for something other than they are to be labeled.

VANILLA TONKA EXTRACT.

Vanilla	1 ounce.
Tonka	2 "
Alcohol, deodorized	32 fluid ounces.
Sirup	8 "

Cut and bruise the vanilla, afterward adding and bruising the tonka; macerate for fourteen days in 16 fluid ounces of the alcohol, with occasional agitation; pour off the clear liquid and set aside; pour the remaining alcohol on the magma, and heat by means of a water bath to about 77° C., in a closely covered vessel. Keep it at that temperature for two or three hours, then strain through flannel with slight pressure; mix the two portions of liquid and filter through felt. Lastly, add the sirup. To render this tincture perfectly clear it may be treated with pulverized magnesium carbonate, using from ½ to 1 drachm to each pint.

ARTIFICIAL VANILLA EXTRACT.

Vanilline	3 drachms.
Cumarine	1 "
Water—enough to make	2 gallons.
Glycerine	4 fluid ounces.
Alcohol	32 "
Caramel—about	2 drachms.

—Pharmaceutical Era.

Powder to Keep Moths Away.—

Cloves	2 ounces.
Cinnamon	2 "
Mace	2 "
Black pepper	2 "
Orris root	2 "

Powder coarsely and mix well together.

Kid Glove Cleaner.—

White castile soap, old and dry	15 parts.
Water	15 "
Solution of chlorinated soda	16 "
Ammonia water	1 "

Cut or shave up the soap, add the water, and heat on the water bath to a smooth paste. Remove, let cool, and add the other ingredients and mix thoroughly.

For Falling Hair.—It is reported, according to the Gazetta Internazionale di Medicina Practica, that a lotion made by the following formula has proved very efficacious in the hands of many:

Hydrochloric acid	75 parts.
Alcohol	2250 "

This lotion is to be applied to the scalp every evening at bedtime.

Menthol Preparations.—A recent issue of the Giornale di Farmacia contained a number of formulæ for menthol preparations, some of which are here reproduced:

MENTHOL VINEGAR.

Menthol	3 parts.
Vinegar	97 "

To be used with water as a gargle.

MENTHOL TOOTHACHE DROPS.

Menthol	8 parts.
Chloroform	8 "
Alcohol	84 "

MENTHOL ICE.

Spermaceti	10 parts.
Paraffine oil	10 "
Menthol	10 "

Melt the first two and add the third ingredient. This is to be rubbed on the nose for catarrh.

MENTHOL SMELLING SALT.

Menthol	10 parts.
Alcohol	78 "
Water of ammonia	12 "

Dissolve the menthol in the spirit, and add the water of ammonia.

MENTHOL ANTICATARRHAL.

Menthol	15 parts.
Boric acid	30 "
Ammonium chloride	55 "

MENTHOL OINTMENT.

Menthol	10 parts.
Paraffine oil	5 "
Hydrous wool fat	85 "

Melt the oils together and add the menthol. The ointment is to be rubbed on the forehead for the relief of headache, etc.

Bicycle Tire Cement.—The following is recommended as very good for cementing pneumatic tires to bicycle wheels:

Shellac	1 ounce.
Gutta-percha	1 "
Sulphur	45 grains.
Red lead	45 "

Melt together the shellac and gutta-percha, then add, with constant stirring, the sulphur and red lead. Use while hot.

Mounting Photographic Prints.—To prevent photographic prints from curving when dry, a paste must be used containing as little water as possible. The following formula is recommended:

Gelatine	2 parts.
Water	4 "
Alcohol	8 "

The alcohol is added slowly as soon as the gelatine is well dissolved in the water, and the vessel turned continually to obtain a homogeneous mixture. The solution must be kept hot during the operation on a water bath, and should be applied quickly, as it soon dries; the print must be placed exactly the first time, as it adheres at once. The solution keeps for a long time in well-corked bottles.—The Druggists Circular and Chemical Gazette.

TRADE SUGGESTIONS FROM UNITED STATES CONSULS.

Clocks in West Africa.—Consul Marshal Halstead writes from Birmingham, August 10, 1900:

Under the caption "An anecdote and a moral," Sells' Commercial Intelligence condenses in the following shape a London Daily Chronicle funny story, "showing how a firm of British merchants were beaten by foreigners in consequence of supplying a superior article":

A prominent firm of London clock manufacturers recently discovered that a rival German company were doing a large trade in cheap clocks which were sent out to the west coast of South Africa. They got hold of a sample and, finding that there was a heavy profit on the sale, invested a large sum of money in making a better article, thousands of which were shipped to the same market. Sales were very slow, while the inferior German production sold freely. Finally, the explanation came. Savages like noise. The clocks made by the original exporters had a particularly loud and aggressive tick. Their imitators made a better clock, but it was almost noiseless, and the savages would have none of it. The remedy was simple. The next shipload that was dispatched by the English firm were of vile construction, but ticked loud enough to wake the Seven Sleepers, and the natives were delighted. Thus was virtue unrewarded, while astuteness was loaded with good things.

American Skilled Labor and Machinery in Breslau.—R Dorndorf's shoe factory, of Breslau, has engaged an American and his wife to take charge of and reform the works. The factory, the largest in Germany, employs 450 hands, and is entirely equipped with American machinery, as follows: Four dieing-out machines, 2 channeling machines, 2 rolling machines, 2 randing machines, 1 box-toe shaver, 1 rough rounder, 1 automatic leveling machine, 5 McKay sewing machines, 1 heel-edge trimming machine, 1 universal slugging machine, 1 McKay slugging machine, 4 Millen twin-treeing machines, 1 Rockingham heel-finishing machine, 8 McKay lathing machines, 3 Goodyear welt machines, 1 Gordon tacking machine, 1 beating-out machine, 1 sole-laying machine, 1 cementing machine, 4 Goodyear stitching machines, 3 edge-trimming machines, 2 heel-scouring machines and 3 buffing machines. All brushes, bottom-finishing material, ink, stains, paints, etc., are of American manufacture.

The American is engaged for one year at a salary of $90 per month; his wife receives $36 per month; and traveling expenses to and from the United States are paid. The wages paid in the factory to the different hands vary from $4.28 to $5.95 per week.

Before the American took charge the factory produced 142 pairs of shoes per day. After the lapse of only eleven days, it turned out 462 pairs, or over three times as many as under the German manager, with the same machinery and same number of hands. They expect to produce, by September 1, over 500 pairs of shoes per day. As the men turn out more work, they receive more wages, these having been increased already 2 marks (48 cents) per week each; and when they produce over 500 pairs of shoes per day, the wages will again be increased 48 cents per week. The German mechanics in the factory are pleased with this way of doing business.

Another American is employed here by the phonograph factory of H. Meinecke. Another, a technical engineer, is engaged by the iron works at Laurahuette, and an American firm is putting up electric apparatus by American mechanics in Kattowitz. American machinery of all descriptions is being introduced in this district, and if our manufacturers would send traveling men speaking German to this industrial center, or establish agencies here, they could build up a good trade.—C. W. Erdman, Consul at Breslau.

American Shoes in Germany.—In reply to an inquiry from an American trade journal, says United States Consul Brainard H. Warner, Jr., of Leipzig, as to the probability of introducing American shoes into Germany, I have the following to say:

The subject of introducing American shoes into Germany has often been written upon by United States consuls. It seems to be the general opinion of those who have looked into the question that there is a market in this country for American shoes. True, during the past few years the trade in shoes has increased, but to nothing like the extent it should have and that it will in due course of time. Why the sale of our shoes in this country has not assumed any great proportions is, in my opinion, due to the following reasons:

The first, and perhaps the most important one, is that, up to within a short time ago, the large shoe factories in the United States were not in a position to consider entering into the export business. (I make this assertion because two years ago a gentleman in New York city was desirous of importing shoes into this country and wrote to the largest shoe factories in the East. Each factory in turn replied that it was not in a position to consider any foreign business, as the orders on hand were for more than could be turned out.) The demand in this country has been created by Americans residing abroad and by those Germans who have become familiar with American foot wear. This has compelled certain shoe dealers to carry in stock a small number of American shoes. The prices asked for these shoes are in most cases too high and out of all proportion to their actual value. It may be that the shoe merchants have to pay more for these shoes because they are compelled to buy through a commission house; but in any event the additional cost per pair, including duty, freight, commission, and insurance, between this country and New York, should not exceed 25 cents. In spite of this fact, $2 and sometimes $3 more than the same shoes would cost in the United States are asked. The German shoe dealer who handles our shoes appreciates the fact that those who insist upon wearing the graceful and easy American article would rather part with a dollar or two more than be forced to buy a poor German substitute. As for Germans, none but the rich would even think of asking for American shoes, because they have learned the exorbitant prices demanded for them.

The people of this country have radically wrong ideas about everything of American manufacture. The masses are taught by the energetic and patriotic "home-trade" shopkeeper that a manufactured article, to be expensive, has but to come from the United States. So it will be seen that American shoes are systematically kept out of the reach of the people by the dealers putting up the prices.

I have endeavored to explain why shoes have not been sold in this country; now I shall attempt to point out how they can be successfully introduced and sold in large quantities.

First of all, I take it that the conditions at home have changed since two years ago, and the time has come when American shoe manufacturers are ready to consider the export field in a serious way. What I have to say in general with regard to importing shoes into this country from the United States applies to many other lines of our goods as well. It must be considered that the trade in American shoes in Germany is yet in its infancy; that our foot wear is practically unknown to the masses.

Our great Western pork-packing establishments would not put their agencies for Europe into the hands of those who sell German pork; nor would a Connecticut watch company give its European agency to a Swiss watch manufacturer. The German or Swiss could not help discriminating and would sell his own products first. Shoes cannot be sold in this country in any large quantities as long as they are placed in the hands of German shoe dealers, who not only can buy shoes on better terms from factories in this country, but who, without doubt, have a great amount of commercial patriotism, a quality hardly known in the United States.

American shoe dealers must work together in their efforts to secure a hold on foreign markets. The day for underselling one another and cutting each other's throats has passed. To deal with the export business, a mutual understanding must be reached.

The people of this country in buying shoes consider, first of all, the price, and therefore we must not expect to sell the high grades of shoes here; what is wanted is a cheap shoe. To sell low grades of shoes, it seems to me the best plan would be to establish a large warehouse in Hamburg or Bremen and open American shoe stores in Berlin, Hamburg, Leipzig, Dresden, and Munich. I am quite sure that, were our merchants to adopt some such plan, they would not only be able to successfully compete with shoe dealers of this country, but that merchants in small cities would be compelled to offer our shoes for sale at the regular retail prices.

Textile Congress at Berlin.—At the meeting of the international textile congress at Berlin, July 16, 1900, Mr. Achille Lepers, delegate of the Textile Syndicate of Roubaix, reported as follows upon the condition of the textile industries in this region:

"The many strikes at Roubaix have assured to workmen, since the passage of the Millerand-Calleard law, the same, or nearly the same, wages for eleven hours' work that they once received for twelve hours. Wages for wool combers are low, varying from 2·25 to 4 francs (44 to 77 cents) per day. Night work still continues, boys working at night and women and children taking their places during the day. It is the least remunerative of the different branches.

"The mean wage for cotton and wool spinners is 5 francs (96·5 cents) and for rattacheurs (fasteners) 3 francs (58 cents). Women employed for the same work earn from 2 to 2·25 francs (39 to 44 cents).

"The weaving branch is oversupplied from the fact that, as the work is comparatively easy, parents prefer it for their children, and this creates a superabundance of labor. There are at least three months in the year when the looms are idle.

"Dyeing is done chiefly by lads, and there is a surplus of production. Weaving is not brilliant either, particularly for machine satins. The mean wage paid for this work is 15 francs ($2.90) per week. The prices for hand work are slightly higher, but there are at least three months a year when there is no work."

Mr. Lepers stated that the only way to ameliorate this state of affairs was to come to some international agreement concerning the shortening of the hours of work and the wages of labor.

The question of abolishing piecework was considered; the English desired its absolute suppression; the French, Austrians, and Germans voted for it; the Belgians abstained from voting.

A resolution to obtain by all legal or other means the abolition of extra hours and night work was proposed; also one in favor of transforming the means of production, now the property of private individuals, into collective property. The Continental delegates thought that the abuses suffered by textile workers could be corrected by legislation. The English delegates believed that the remedy lay in proper organization among workmen. The socialistic resolution was adopted by a large majority.

The congress resolved that strikes lasting more than four weeks and comprising more than two thousand people should be aided by members of all countries, at the rate of 12 cents per week and per member.

The next congress will meet at Zurich, Switzerland, in 1902.—W. P. Atwell, Consul at Roubaix.

German Case-making Industry.—The labor agitation that has been felt in most parts of Germany has affected the china, doll, and toy industry, and workmen have asked for, and in most cases have received, a raise in wages and a decrease of the number of working hours. The latest strike has been in the case-making industry of Sonneberg, an industry that is of surprising proportions when the size of the town—about 13,000 inhabitants—is considered. It is estimated that about $35,000 is expended there for cases in one year, and most of them are made in the town or its immediate neighborhood.

The cases are constructed mostly in small shops, though several of the regular furniture makers and carpenters also add these to their line of work. The proprietors have recently made an arrangement as to prices, uniformity of cases, remuneration for labor, etc. They now all ask the same prices, and there is a cash penalty for any infraction of the agreement.

The combination of the makers was the only possible means of release from the disastrous conditions that prevailed in the trade. Without a mutual agreement, it would have been next to impossible to meet the raise in wages asked for by their workmen and to pay the increased price on all raw materials. With the organization that now prevails, all seem satisfied, and stable conditions will probably govern the industry.

Consular Agent Joy, at Sonneberg, reports as follows:

"A comparison of prices shows a raise of 12 to 15 per cent. over old prices in the cost of the case to the exporter. The new prices will be in force from the 1st of August, but the workmen receive their increase of pay from the middle of July. The wages of the workmen are increased about 2·60 marks (62 cents) per week, being now 19 to 21 marks ($4.52 to $4.99)."

A large quantity of the wood used is grown in and around Sonneberg, though considerable comes from southern Bavaria, where a cheaper article prevails. The cheaper cases, roughly nailed and not glued together on the sides, are often brought in car load lots; they need oil-paper lining and more care in packing than the others. The price of wood has risen in the last ten years 14 per cent. for the thinner pieces or boards; for the cleats nailed outside of the larger cases, about 35 per cent. The wire nails used have risen 80 per cent. The men work eleven hours on five days, and on Monday ten hours. The price of the case is figured by the meter. One mark (23·8 cents) per cubic meter (35·316 cubic feet) is charged for small cases, and 90 pfennigs (21·4 cents) on the large sizes. The difference the new prices will make is from 30 to 80 pfennigs (7 to 19 cents) per case, or from 12 to 15 per cent. over old prices.

American importers will not be affected this year, as it is customary to have the prices fixed for the season. Many manufacturers admit that most of their profit is made in the cases they ship in. The prices of goods are so low that this is the only chance of profit to the seller. Five per cent. of the cost of case is estimated for the straw and labor used in putting up the goods, and this is included in the charge for the cases. Putting an extraordinary charge on cases shipped to United States is not practiced in the German or English trade. In Germany, the cases are in many instances returned to the manufacturer, as the government railroads give a special rate thereon. Prices quoted to England are on goods at store door, no account being taken for cases, but everything being included. Many American buyers realize that they pay an immense profit on their cases, but they cannot help themselves. It is a very hard matter to learn the prices from case makers to exporters.—Oliver J. D. Hughes, Consul at Coburg.

American Lard in Germany.—Consul-General Guenther sends the following, dated Frankfort, July 20, 1900:

The agrarians and some butchers of Germany are trying to create a popular prejudice against the consumption of American meats, and particularly of American lard. The report of the board of chemical examiners of the city of Ulm (charged with the examination of adipose substances or pettwaaren) is of interest in this connection. The report covers the examinations of the last two years, and, after stating that the custom authorities are required to take samples of all large shipments of foreign butter, cheese, margarin, and hog's lard and have them examined, it says:

Samples of American lard are very often received, taken from shipments amounting to several hundreds of pounds. A thorough chemical examination shows that American lard is not only the same as German lard in regard to smell, taste, and consistency, but that it frequently excels in dazzling white color. Among the several samples received there was none to be objected to; the quality was faultless.

Tulle Factories in Germany.—The following, dated Leipzig, July 31, 1900, has been received from Consul Warner:

Those who are interested in German home trade have for some time been urging an increase in the number of tulle weaving factories in this country, and their efforts are finally to be rewarded by the establishment of several new manufactories. The German manufacturers of embroidered goods will thus no longer be dependent upon England for their tulle. The new factory at Kappel is doing a very good business. It has already over eighty looms in operation and is putting in new ones as fast as possible. Another tulle factory has recently been established at Plaue near Flöha. The oldest tulle factory in Germany is at Schneeberg, in the Erzgebirge; it has been in operation more than twenty years and has always been most prosperous.

Glass Industry in Germany.—The manufacture of glass in Germany has become a thriving industry. The number of factories has reached 400, giving employment to about 35,000 workmen. This is a good showing, when it is considered that the production of glass is comparatively a new thing for the empire. For the past thirty years, the import from Austria, Belgium, England, and Italy has not only been rapidly losing ground, but Germany now exports to those countries certain kinds of glass, such as bottles of every description, etc. Naturally, the German manufacturers have not yet reached that stage where they can compete with Belgium in mirrors or with Venice in fancy colored decorations.—Jno. F. Winter, Consul at Annaberg.

INDEX TO ADVANCE SHEETS OF CONSULAR REPORTS.

No. 824. September 4.—German Mask Industry—Quinine Auction in Batavia—Austrian Demand for Watches—*Spanish Commercial Museum in Vienna—Venezuelan Market for Cloak Goods.

No. 825. September 5.—Krupp Iron Works—Demand for Iron Posts in South Africa—Hats in Mexico—*Clocks in West Africa.

No. 826. September 6.—*Economic Conditions in Zanzibar—*Textile Congress at Berlin.

No. 827. September 7.—*American Shoes in Germany—Antwerp Ivory Market.

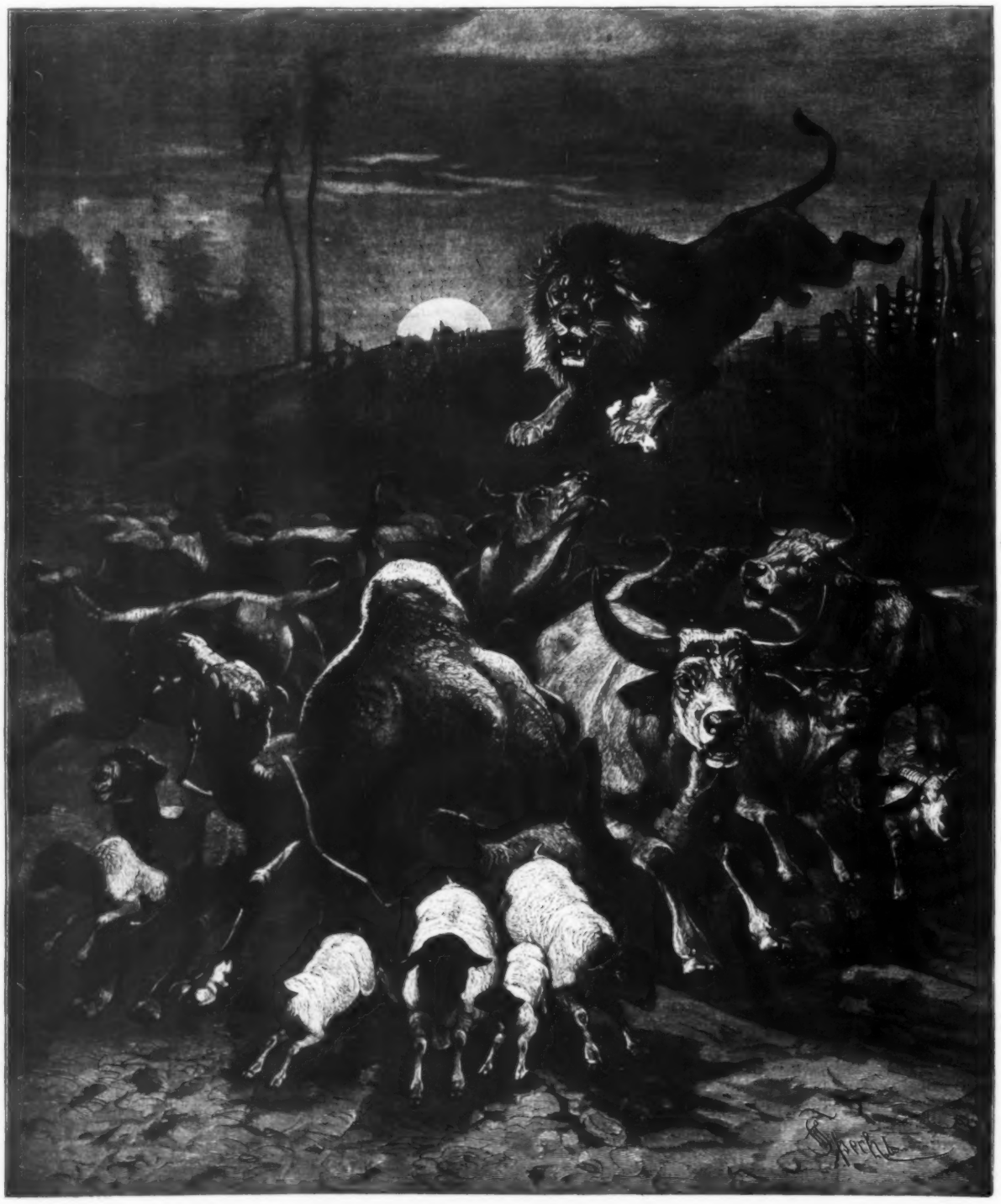
No. 828. September 8.—Tea Cultivation in Malacca—*New Scheme to Push British Trade—*Danger to Health in the Use of Silver-Mounted Ware.

The Reports marked with an asterisk (*) will be published in the SCIENTIFIC AMERICAN SUPPLEMENT. Interested parties can obtain the other Reports by application to Bureau of Foreign Commerce, Department of State, Washington, D. C., and we suggest immediate application before the supply is exhausted.

HOW A LION ATTACKS AN AFRICAN KRAAL.

DESPITE the rapid advance of civilization from the coast to the interior of Africa, and despite the activity of the hunter, armed with his deadly high-power magazine-gun, the lion is still the dread of all domesticated animals. Brehm has given the following most excellent description of a lion's nocturnal attack upon an African kraal:

At sundown the herdsman had driven his cattle within the zareba. Night gradually wrapped the camp in darkness. The wife and children of the cattleman had gone to their tent; the men had finished their last tasks; the cattle slept; and even the yelping dogs were silent. Suddenly the earth seemed to tremble. A lion's roar was heard. Then, of all times, he seemed worthy of his Arabic name, "Essed," the "terror-inspiring"; for within the zareba everything was in commotion. The sheep ran



THE NOCTURNAL ATTACK OF A LION ON AN AFRICAN KRAAL.

frantically against the inclosing barricade; the goats bleated pitifully; the oxen, with loud groans, crowded together in a confused heap; the camel, in his mad fear, broke the thong by which he was bound; and even the dogs, brave fighters of leopards and hyenas, howled with fear and rushed to the tent where their master himself sat trembling. With a powerful leap, the lion cleared the zareba. A single blow of his paw felled a two-year-old child; his strong jaws crunched the bones of its neck. Crouching upon his prey, he growled threateningly; his eyes gleamed with greed. He then retraced his course. All his great strength was required to leap over the zareba with the child in his mouth. But he succeeded. For days the tracks were seen which he left behind him as he dragged the child along in the sand to his lair.

A serious fire occurred on June 24 at the sub-station of the Lachine Rapids Company at Montreal, in which the watchman was killed. The power house was notified by telephone to switch off the current.

COD FISHERIES OF THE NORTHERN PACIFIC.

IN 1899, the Alaska catch of codfish aggregated 1,302,000, averaging two tons to the thousand, or 2,600 tons. This is less than the yield of 1883, when the catch amounted to 1,720,000, the greatest ever known; but that of 1899 was caught exclusively in American waters, while that of 1883, nearly a million, was the product of the banks in Okhotsk Sea, twenty miles off the Siberian coast, from which our fishermen have been excluded for two years, except on the payment of a prohibitive license. This exclusion is regarded by American fishermen as unjust to the last degree, inasmuch as the fishing banks lie at such a distance from the coast as to make them beyond the jurisdiction of the Russian government. The question is one of international settlement, and may be brought about by allowing an American ship to be seized, but this is an expensive proceeding, and rather than subject themselves to the risk the fishermen have, for the past two years, confined their operations to waters whose ownership is beyond dispute.

Owing to the greater distance from the home port, cod fishing in Alaska waters is conducted differently from that of the Atlantic port. The vessels on the Pacific are much larger in tonnage, averaging 200 tons each. There are seven vessels engaged in the Behring Sea fishing and two as tenders, sailing from San Francisco to the banks, making three trips each season. These employ 343 men. Besides there are fishing stations at Pirate Cove, Topof Island, Shumagin Island, Irmak Island, and the mainland adjacent where fishing is conducted throughout the year.

The season for the fishing vessels lasts about seventy days, or, including the time from port, about five months, and the fisherman, paid by the number of his catch, is able to average from $60 to $75 a month, depending upon his skill or luck. The fisherman sits in his dory with two lines from 20 to 60 fathoms in depth, each line with two hooks attached. An average day's work is 250 cod. The fish caught are taken to the ship and there dressed, salted, and stored in bunks, where they remain until the tender arrives, when they are transferred to San Francisco, to be pickled. Here they remain in tanks, holding about 12 tons each, and, as the market requires, they are prepared for consumption. Alaska fish have a standing in the markets of the Far East that is not attained by fish from the Atlantic banks, owing, it is said, to the fact that the Pacific coast dealers are more scientific in their mode of preparation for the market, one peculiarity being that the Alaska fish is much whiter in appearance; the necessity of promptly cutting up the fish as soon as caught allowing all the blood to flow from out the carcass. On the Atlantic, the contiguity of the home ports allows the fish to remain uncut until they are eventually delivered to the warehouse on the mainland. In San Francisco a large number of men are engaged in hauling the product of the cod fisheries, for which there are extensive warehouses and stores. At the fishing stations on the islands and mainland of Alaska there are ninety men employed in the fisheries and marketing throughout the year.

It is said that the product of the cod fishing banks of Alaska is decreasing from unexplained causes. It is thought that, possibly, throwing back the waste from the dead fish may have the effect of driving the cod from long-frequented waters, or that the depopulation of the banks is the result of some habit or instinct which causes them to absent themselves from familiar haunts at certain periods. Certain it is that in both numbers and size the Alaska cod are now below the average of former years.

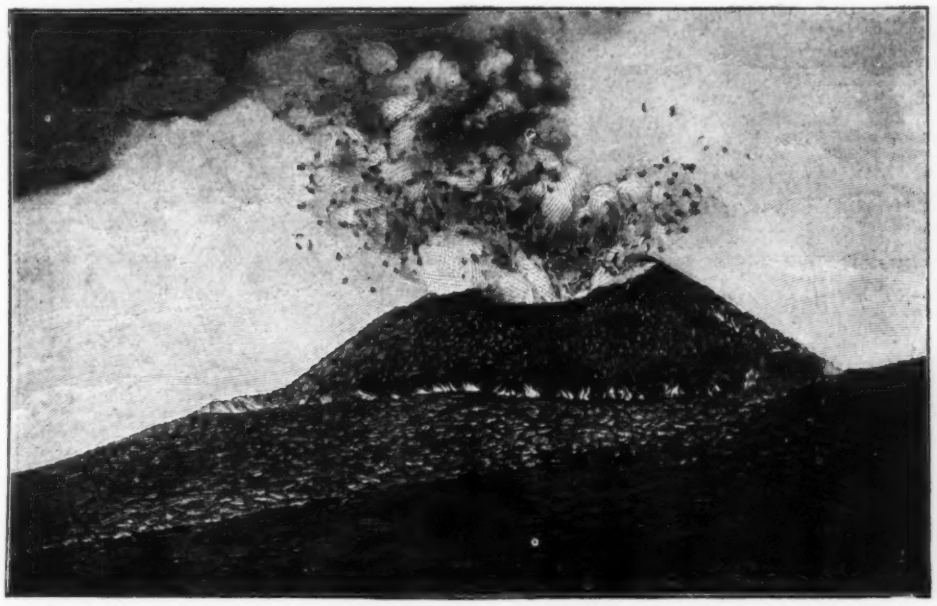
The English Admiralty have decided to establish a naval base at Simon's Bay in South Africa. The necessary alterations and constructions of the harbor works, and so forth, are to be undertaken by Sir John Jackson, whose tender has been accepted by the Admiralty. The cost of the work will be $12,500,000.

THE LATEST ERUPTION OF VESUVIUS.

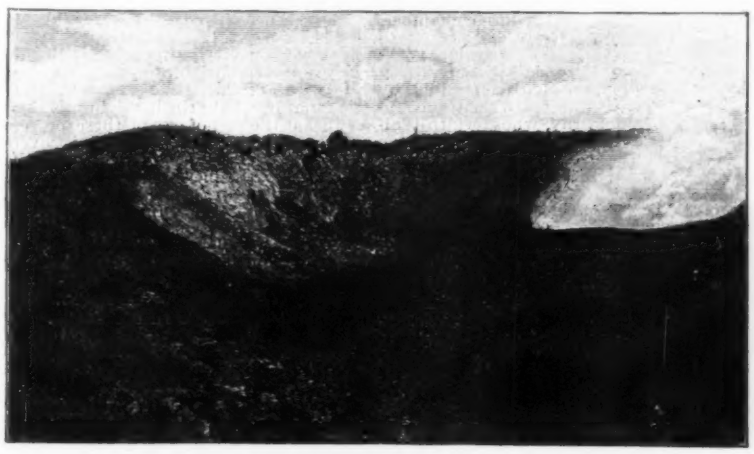
FOR years the great volcano of Italy has been dormant. The inhabitants who had settled along its base and on its slopes, in the towns of Torre del Greco, Cugliano, San Vito, etc., had so long lived undisturbed by any eruption that they had ceased to fear Vesuvius. But in the spring of the present year the volcano again began to vomit lava and to rain glowing cinders and ashes upon the nearby villages. Although the last eruption was far less violent than the previous outbreak (April 6, 1872), nevertheless much damage was done. For weeks the people living on the shore of the Gulf of Naples passed no peaceful night. Blocks of lava of huge size were hurled up to a great height and fell back into the crater. For the past twenty years a two-tracked cable railway has been in operation on the slopes of Vesuvius. This railway suffered no little damage.

The form of the summit of Vesuvius is constantly changing. And this latest eruption has also left its marks on the crater.

Alexander von Humboldt very carefully observed and described the eruptions of 1822 and 1846. But instruments for detecting and measuring seismic vibrations, if not unknown in his day, were at least so very far inferior to our modern apparatus that he could not possibly have accurately noticed every change which occurred during the disturbance. The modern observatory of Monte Somma is equipped with instruments so accurate that an eruption can be foretold with such nicety that the people in the surrounding villages can be warned in time to escape the impending danger. The one hundred thousand persons living about Vesuvius were therefore informed days before of the eruption about to occur and were enabled to seek places of shelter.



THE ERUPTION OF VESUVIUS.



THE GREAT CRATER OF VESUVIUS.

THE OLDEST LIBRARY IN THE WORLD.

AMERICANS have again made an interesting discovery in Babylonia. As announced by cable several days ago, the expedition under the auspices of the University of Pennsylvania, and under the direction of Prof. Hilprecht, has found at Nippur, one of the four cities mentioned in the Book of Genesis, the library of the great temple, the age of which is upward of 4,000 years. The Daily News of London prints an interesting article about this discovery, from which we take the following:

"The Daily News was the first to inform English readers, three years ago, of the remarkable discoveries at Nippur made by the expedition sent out by the Pennsylvania University. These discoveries carried back the history of the Babylonian civilization to a period more than seven thousand years before Christ. Nippur itself had then been identified with Calneh, one of the four cities mentioned in the Book of Genesis (chapter x., verse 10) as the beginning of the kingdom of Nimrod, 'the mighty hunter before the Lord,' and also as the place to which Nebuchadnezzar brought the captives of Judea. The chief—or, as he is called, the 'Scientific Director'—of the American expedition, to whom these latter discoveries are mainly due, is Prof. Hilprecht, who has just returned to Constantinople, doing the journey in this hot season on horseback. Part of his road (from Mossul to Mardin) led through the then very unsafe district of the Tai Bedouins, who were at war with the powerful Shammar tribes. The energy he has shown in this journey, where he has astonished everybody by remaining in the saddle twelve to eighteen hours daily, and on one day twenty-one hours, is characteristic of the man. I have had the opportunity of learning from him what are the principal results of this year's work, and hasten once more to put your readers in possession of them.

"First and most important is the discovery of the library of the great temple at Nippur. As far back as eleven years ago, when Dr. Peters of New York was at the head of the expedition, Prof. Hilprecht pointed out that the remains of this library would be found at the very place where the discovery has taken place this year. The find has been much more important than could have been anticipated. In the course of three months, no less than 17,200 tablets, covered with cuneiform writing, have been recovered. These are not of the character mentioned in my former notice of the discovery of tablets, namely, the recovery of private business contracts, conveyances, letters, and the like, but bear more resemblance to the contents of an ordinary library. The tablets are historical, philological, and literary. They treat of mythology, of grammar and lexicography, of science, and of mathematics. There is reason to believe that they will for the first time enable the world to form an adequate idea of life in Babylonia such as only could be possible by the discovery of a national library, recording the national progress in literature, science, and thought generally. No document is found in this collection of a later date than 2280 B. C. As this date marks the invasion of the Elamites, the fact adds confirmatory evidence that the library was destroyed during this invasion.

"The unexplored remains of the library are even more extensive than those already examined. The tablets are generally arranged with regularity on clay shelves around the rooms of the library, and Prof. Hilprecht estimates that at their present rate of working five more years will be necessary to excavate and examine the contents. He thinks it probable, judging from the contents already found in the rooms excavated, and from various other reasons, that the unexplored part will yield 150,000 tablets to be added to those already discovered. As the library was one of great renown, the chief glory of the temple in early Babylonia, the chief college for instruction in law and religion, which as in all early systems were inextricably bound together, and, indeed, in all studies judged worthy of attention, it is evident that no examination of the contents can be too careful. It is, in fact, hardly too much to say that if the unexplored parts should prove as rich in results as that already found, there will be no example in the world's history, not even in Egypt, of so complete a recovery of the records of an ancient civilization.

"The American expedition had to suspend its investigation of the great library temporarily in order to continue its systematic work at the temple and to complete the examination of the south and eastern lines of the walls of fortification of ancient Nippur. These walls show clearly the different epochs in which they were constructed. There are, first, portions of which the builders were the pre-Sargonic rulers. These are followed by the works of Sargon (3800 B. C.) and of Narum-Sin, his son; then about a thousand years later are the fortifications of Ur-Gur, to be followed by the later Cassite kings, belonging to the comparatively modern period of from 1700 to 1100 B. C. The numerous weapons found along the whole line of fortification, especially in the lower strata, were welcome material for determining the methods employed by besieging armies in the earliest periods of Babylonian history.

"In the course of the present excavations a palace belonging to the pre-Sargonic period was uncovered beneath an accumulation of seventy feet of rubbish on the southwestern side of the Shatt-en-Nil, dividing Nippur in two parts. Prof. Hilprecht himself, having never been doubtful as to the actual site of the temple library at Nippur since his first visit to Babylonia in 1889, considers the discovery of this large building, with 600 feet frontage, which will probably turn out to be the palace of the early priest-kings of Nippur, as the most important result of this year's campaign. Already the few rooms excavated have given valuable results in the shape of pre-Sargonic tablets, of seal cylinders of the earliest type, and clay figurines of early date and great interest. The palace was very extensive and at least two stories high. At a later period it had been used as a chief quarry for furnishing materials

THE CABLE ROAD LEADING TO THE CRATER OF VESUVIUS.

for public and private buildings in Nippur. From the indications which have been met with, both in the palace itself and in the materials which have been taken from it for building purposes, Prof. Hilprecht anticipates that statues will probably be found of a character similar to those which the French expedition has discovered at Tello.

"Other discoveries made by the Philadelphian expedition are of value. Some of the earlier conclusions have had to be corrected. The large building discovered at the beginning of the first campaign, a portion of which was unearthed by the Rev. Dr. Peters, the first director of the expedition, a comparatively well-preserved structure, with a remarkable colonnade, has now been excavated completely and its character has been ascertained. It proves to be a thousand years later than Dr. Peters judged it to be. It is a work of the Persian or Parthian period. The later cruciform structure of the temple, which aroused considerable interest because of its form and magnitude, appears by this year's exploration to have nothing to do with the temple proper, but to be a strong fortification constructed some time during the last two centuries preceding our era, and of considerable importance even at the time of the first Roman emperors, when the Temple of Bel was in ruins, having ceased to be a sanctuary.

"Beyond doubt the greatest success of the year is that accomplished by the American expedition. The importance of the discovery of the pre-Sargonic palace and of the library of so famous a temple as that of Nippur was at once recognized. The systematic and thorough examination which it is hoped will be made next year promises to give a full and detailed picture of life in what the author of the Book of Genesis regarded as one of the oldest cities in the world, and one whose origin, even in his time, was attributed to the famous hunter whose name has become mythical. The results of the explorations will probably show that Nippur was as important in the fifth millennium before Christ as it was in the third, that it anticipated the civilization and the period when Babylon took the lead by at least 2,000 years, and that at this early period the human race in Babylonia had acquired arts and knowledge which hitherto have only been attributed to a much later period.

"In conclusion, it should be noted that this American expedition is one of the many valuable results which are due to the magnificent generosity of American citizens. The Provost of the University of Pennsylvania, formerly Dr. W. Pepper, and now Dr. C. C. Harrison, assisted by a number of Philadelphia gentlemen, prominent among whom are two bankers, Mr. E. W. Clark and Mr. C. H. Clark, the first-named being the Chairman of the Committee of Babylonian Exploration, deserve credit for their devotion to this purely scientific cause. From the commencement of the explorations, some ten or twelve years ago, they have been prominently connected with it."

THE MYCENÆAN HOUSE OF THE DOUBLE-AX.

SINCE the days of Dr. Schliemann's discoveries, nothing has made an epoch in European archæology in the sense attaching to those words when used of the revelations for which we have to thank the indomitable energy and unflagging enthusiasm of our compatriot by adoption. But now, since Mr. A. J. Evans has returned from his last archæological campaign in Crete, we are fairly entitled to say that a new era has dawned upon us, and that the blank spaces in the earliest records of European letters and arts are soon to be filled up by an array of new facts.

Six years ago, Mr. Evans discovered in Crete a system, or, rather, two systems, of writing older than that of historic Greece, and distinct from the Phœnician, as well as from the so-called "Hittite" of Asia Minor. The characters of this script he found on seal-stones, and, finally about two years ago, on a steatite libation table unearthed in the Dictean cave of Zeus. This last was demonstrably of the Mycenæan period. Naturally our investigator's thoughts turned to Cnossos, "the city of Minos and Dædalus," and the "traditional center of early Cretan civilization." Indeed, as early as 1894, he copied linear characters from a Cnossian seal-stone, and obtained further indications from that site, which confirmed him in a wish to make systematic excavations there.

Mr. Stillman had attempted to dig on the site, attracted by the presence of Mycenæan pottery, and by curious signs upon stone blocks showing on the hill of Cephala, near the modern town of Candia. Dr. Schliemann also had striven to secure the right to excavate the site. But all efforts were defeated by the impossibility of coming to terms with the Turks in possession of the land.

Such was the situation until the undiscouraged Mr. Evans obtained an undivided sixth interest in the site. This was in 1896, but the difficulties which he overcame between that time and the beginning of his excavations upon the site early in April last, have been innumerable. First came a lawsuit culminating in a forced sale, at which the Turkish joint owners purchased Mr. Evans's share at a preposterous price—which they failed to pay. Then came the Greco-Turkish war and the whole imbroglio of the European concert, followed by a claim to excavate on this site made by other archæologists. Last of all there was a new law-suit culminating in a second sale, at which Mr. Evans finally succeeded in obtaining control of the whole site. Apart from a certain assistance covering only a fraction of expenses incurred, Mr. Evans has defrayed the cost of all operations. It is, indeed, to be hoped that the Cretan exploration funds upon which he may in future be able to draw, will be swelled by those who appreciate the far-reaching and universal value of the results obtained.

The site of Cnossos lies on a hill about four miles to the south of the modern Candia, which the Cretans are rebaptizing Heracleion. The hill was popularly known as *του τσελεβη η κεφαλα*, or "The Chief's Head." A Cretan explorer, Kalokærinos by name, excavated there in 1877 and found Mycenæan walls and potsherds identified as such by Haussoullier and Fabricius. Fabricius was struck by resemblances to leading features of known Mycenæan palaces. Stillman, in 1881, identified the building as the "Labyrinth" of mythological fame, and now Mr. Evans, after a careful and complete excavation of one-half of the site, finds that both Fabricius and Stillman were right.

A striking confirmation is found, in the sculptured double-ax abounding on the square gypsum stones used in the construction of this Mycenæan palace, of the explanation of the Labyrinth as meaning the House of the Double-Ax. This same double-ax (*λαβρυς*, given by Plutarch as the Carian for battle-ax) supplied a well-known epithet to Zeus in Caria, and figures in both the linear and the pictorial alphabets of Mr. Evans' discoveries as a significant character. Cnossos, then, was the site of the House of the Double-Ax, which was also the Palace of the Cretan King Minos, whose authenticated relations with Caria and the Carians make the designation of his palace by the Carian name of Labyrinth a very natural one.

The part of the palace laid bare by Mr. Evans reveals a complex of walls, not yet sufficiently studied to yield a determinate ground plan. The material used for most of the partition wall was rough-quarried stones, compacted together with a clayey compound, and there is a plentiful use of something not unlike white-wash upon wall surfaces. The more solid walls, however, are often built of beautifully squared gypsum blocks, superior in their workmanship even to the much-admired walls of the sixth Trojan city, identified with Homer's Ilium. Sills and pillars are all of stone, as far as the first story reaches. There are unmistakable signs of numerous wooden columns which rested on stone bases that are still well preserved. There was an upper part of the building made of wood.

The whole of the excavated portion of this palace of Minos falls into two unequal parts, extending to the east and west of a long and narrow corridor, which runs nearly due north and south. Opening upon this corridor are a series of long and narrow magazines, which lie to the west of it, and were used for the storage of wheat and the like. This western side of the palace suggests, in the general effect of its ground-plan, what we might call a labyrinth, and in each of its long magazine-rooms are subterranean storage-places, which appeared to have been lined with lead. The incised representations of the double-ax abound in this part, so that, if the name Labyrinth were specially to be applied to one part rather than to another, it would attach to this westernmost complex of buildings.

Rather the larger half of the portion excavated lies upon the eastern side of the long corridor above mentioned, and might be distinctively called the palace of Minos, since it contains, among various rooms not yet very definitely disentangled, though all belonging to the natural ground-plan of a Mycenæan palace, the council-chamber of Minos. This is a large chamber, nearly square, with an anteroom of almost equal dimensions. The anteroom, which had for the most part been already excavated, is approached and entered by a short flight of stairs and four doors separated by narrow door-posts. It communicates with the council-chamber by means of a doorway, whose width is almost that of the whole partition separating the two rooms. The council-chamber itself falls into two parts. To your left on entering, steps lead down to a square water-tank, whose bottom level is about five feet lower than the floor of the rest of the council-chamber. Three carefully chiseled circular holes show that there were three cedar posts or columns extending from the balustrade which fenced off this tank from the council-chamber, to some sort of a roof, which covered it in. This fact shows that there was no roof covering the council-chamber as a whole, the central part of which was open to the sky. Opposite this balustrade and screen, and facing the tank, is the throne of Minos, with stone benches on either side of it, presumably for his councilors. The judgment seat of Minos is supplied with a stone foot-stool, and is a chair fashioned out of solid gypsum. Its proportions are more or less those of the throne of England in the choir of Westminster Abbey. It is a chair with four straight legs and a very high straight back, the nine wavelike curves of whose contour closely reproduce a magnified oakleaf of the lobed variety. Between the two front legs of the throne is a curious panel suggestive of a Gothic arch, though not quite pointed, and decorated with four crockets which are strikingly Gothic in their outline and decorative effect. The back of the throne is all but embedded in the surface of the wall, which still bears clear remains of plants painted in fresco. Traces of similar fresco work are plain elsewhere on the walls of this chamber, and there are two remarkable griffins with unmistakable peacock feathers on their heads, and cross-hatchings to indicate shadows and give relief to the modeling of their bodies. This is a remarkable technique when we compare it with that of red-figured vase-paintings, and the peacock feathers come as a surprise in such early work, since the Greeks are not usually supposed to have known the peacock until a rather late date.

The only other feature of the council chamber worth mention here is a small alcove which probably was used for bathing. The general plan of a central space open to the sky, and an adjoining tank-room, has a certain resemblance to similar features in well known buildings of Egyptian antiquity. It may be well to mention that an Egyptian statue, clearly marked by its inscription as of the early twelfth dynasty, was unearthed in the palace, where also were found various unmistakable traces of the eighteenth Egyptian dynasty. These discoveries serve to give us roughly the chronological limits within which the Cnossian Labyrinth was built. It has yielded, says Mr. Evans, "hardly a scrap of anything later than the great days of Mycenæ, or, to give an approximate chronology, the fourteenth century before Christ."

But, to return to the palace of Minos, we have not yet done with its frescoes. A marvelous stroke of luck has preserved considerable remains of the large frescoes in a spacious corridor by which, apparently, a large open court was approached. The final catastrophe which befell all the buildings on this site more than three thousand years ago was a conflagration that might easily have destroyed all traces of wall painting, since it performed the useful function of baking the tablets of unburned clay bearing inscriptions which Mr. Evans has found in various chambers. The large wall paintings in question fell to the ground face downward, and this fall, like the similar one of the Hermes at Olympia, has been a godsend to the archæologists of to-day. Had the wall stood upright through all these centuries, there would have been nothing left of the frescoes to-day, for the whole building lies very close to the surface of the soil—the back of Minos' judgment seat, for instance, was separated from the level ground above it only by about four feet of soil. Of this large fresco, then, only the very lowest part, showing two pairs of red feet and one of white feet, belonging respectively to two men and one woman, remains in situ.

Of the original effect the following description appears to be true. On both sides of the corridor were processions, much like those adorning certain early Egyptian tombs, consisting of youths painted very nearly the size of life. These youths are naked except for a hip-cloth of beautiful texture and brilliant pattern (rosettes, scales, and the like), which is hung from the waist quite over the hips and nearly half-way down to the knees. This cloth is of almost gossamer lightness, and is held down by weights such as were used to maintain the adjustment of their robes by the latter-day Greeks. There are several details in the disposition of this very scant drapery which strongly resemble similar effects in Egyptian pictures. Also, there seems to be indicated, behind the youths' legs, some sort of a stream of water, and this encourages the notion that these figures were tribute-bearers from beyond the streams of ocean. Strikingly enough, the wrists of these figures are adorned with blue (silver) bands, to which are attached oval stones, the counterpart of those "island stones" upon which Mr. Evans first discovered characters of the Mycenæan alphabet. These youths have long hair hanging unconfined down their backs, and are moving toward a female figure, identified by two white feet and the hem of a highly variegated robe. Among the marching youths here and there are heavily draped figures of men and occasionally a woman. These were plainly magnates decked out in full festal attire.

It is not, however, in these ceremonial robes and magnificent personages that our interest centers. The tribute-bearing youths, especially, of course, the one marvelous figure among them which is preserved almost entire, come to us, out of the dark backward and abyss of time, clothed in a youthful brightness and perfection of manly beauty which far outshine the known perfections of Mycenæan art as elsewhere unearthed. Looking at these youths, we feel that the perfected art of vase painting in the red figured style of the fifth century B. C. was, after all, no new departure, but a revival. And yet the one youth's face, seen in profile, that has been unearthed is by no means definitely of the generalized Greek type, it is far more individual. We seem to have before us, united in the prehistoric perfections of early Cretan art, the realistic style of the earliest Egyptian dynasties (cf. the well-known statuette of the scribe in the Louvre) and the idealizing manner of the sculptors and vase painters who preceded Phidias.

That the Labyrinth might not lack its bull, there was, at the end of one of these processional paintings, a painted bull. This painting covers three independently frescoed surfaces, upon each of which in its day had stood the picture of a bull. Nor were other representations of bulls lacking in this, the Minotaur's lair. The head of a bull and parts of its body, the whole modeled with consummate skill in high relief and wonderfully painted larger than life, has been unearthed on this site. Wonderful as the technique of the bulls on the Vapheio cup undoubtedly is, this Cnossian bull is of even finer workmanship. To proceed from the colossal to the minute, let us here mention a curious piece of crystal, found also by Mr. Evans, which bears upon it the enameled miniature of a bull. Here, again, the technique is marvelous, and the glittering intensity of life which looks out through the bull's eye from this miniature has the speaking power of the wonderful donkey's eye that looks out from behind Watteau's well-known "Pierrot" in the Louvre.

Even yet we have not done with the frescoes discovered by Mr. Evans in the Palace of Minos, for the greatest surprise of all in many ways is the discovery of another group of wall paintings, the remains of which are, unfortunately, almost pulverized. These fragments have been ingeniously pieced together, and even more may be made out of them by further industry and skill. Their scale is as small as that of the tribute-bearing procession is large. They are miniatures executed in a very sketchy style, but with a freedom of hand and an eye for the attitudes of aristocratic ease and graceful savoir-faire which are simply amazing. The chief interest here centers in groups of extremely well dressed ladies, belonging, it would seem, to the most exclusive circles of a highly organized social world. They are swiftly sketched in on a white background, and are sitting in the open air. One of them has seated herself near the horn and pillar of a temple, the counterpart of which may be found on various Mycenæan seal rings. All of them are décolletées to an extent which prompts a hope that traces of some sort of a gossamer fichu may eventually be made out. Their attire is otherwise most elegant, and the curled tresses of their coiffures form a pleasing feature in their picturesque silhouettes. Far more sketchy are the groups of men similarly sketched in black on a reddish background. These are for the most part merely the outlines of various male profiles. The effect of a crowd achieved in all these groups is quite unique.

Space is lacking for discussing the rich and various vases, jars, lamps, and the like, which Mr. Evans found in several corners of the great palace. And I can say but a word of the vast accumulations of inscribed clay tablets which form a part of the new discoveries that has a universal importance. Of these Mr. Evans has spoken in detailed letters to The Athenæum of May 19 and June 23, 1900. The tables are "oblong slips of hand-molded clay, flat on the engraved sides, with almost adzlike ends, but thickening toward the center of the back." They vary in length from about two to upward of seven inches. They were found in receptacles of wood or clay, and the clay seals with which they were secured have been found. These seals still bear the impressions of engraved Mycenæan gems, and in many cases have been carefully countersigned (presumably by some superior officer) both on the front and the back. It seems tolerably sure that a large portion of them relate to palace accounts. One set plainly refers to chariots, and on another group are

discovered pictorial representations of Mycenæan vases and the like. Numbers, of course, abound on these inventories.

As to the characters of the script, several of them are identical with linear forms found on Cretan seals of the same period. Affinities with the Cypriote syllabary and with Lycian and Carian characters are not lacking. Let it be understood that the above description applies solely to the first one thousand-odd inscriptions discovered at Cnossos, and that the numerous characters thus discovered (sixty-seven have been so far distinguished by Mr. Evans) chiefly resemble one of the systems previously discovered in Crete and the Aegean in being linear rather than pictorial. The execution of these Cnossian linear descriptions shows a firmness of touch and deftness of hand not achieved elsewhere. Their general aspect has the beauty of archaic Greek inscriptions, and is palpably not of Babylonian, Egyptian, Hittite, or Phœnician inspiration. Here, as Mr. Evans says, we have "the work on Cretan soil of an Aegean people."

Quite apart from these linear characters are the pictographic inscriptions found last of all by Mr. Evans in one of the "magazines" of the Labyrinth. The clay tablets here found are inscribed with a "hieroglyphic" type of writing identical with the pictographic characters long since published by Mr. Evans from various prism seal stones of Eastern Crete. This system is more or less obviously allied to Egyptian hieroglyphics, although it embraces not a few linear forms. It is probably pre-Mycenæan, and plainly was at home among the Eteocretes of the region of Mount Dicte.—Louis Dyer, in The Nation.

[Continued from SUPPLEMENT, No. 1289, page 20661.]

THE MISSION OF SCIENCE IN EDUCATION.*

By JOHN M. COULTER.

BUT I have still stronger claim to make for science as an essential constituent of all education and that is:

2. It gives a training peculiar to itself, and one that is essential in every well-balanced education.—The real educational significance of the training in laboratories devoted to science is very commonly overlooked, both by those who know nothing about it from personal experience, and even by those who are teachers of Science. Many learn to go through the motions without appreciating the substratum of educational philosophy. Moreover, the knowledge of the educational significance of this special form of training has been slowly developed as the results have appeared.

Perhaps the earliest and of course the most superficial form of statement explaining the purpose of scientific study was that it teaches the laboratory method. The inference was that the sciences are of no particular educational advantage in themselves, but are merely useful in teaching a valuable method. In so far as this emphasized the fact that reading or reciting about science cannot be regarded as training in science, and in so far as it recognized that science is to be credited with introducing a revolutionary and invaluable educational method, the statement is true enough; but to regard these purely incidental results as being in any sense the end of scientific training is far enough from the mark. The laboratory method holds no more relation to science than do algebraic symbols to algebra; they both merely represent useful machinery for getting at the real results. And further, as has been shown, if the teaching of a method is the only function of science in education, when this method has been learned and has become universally applied, the mission of science in education is at an end.

Another commonly stated advantage of training in science is that it cultivates the power and habit of observation. This is certainly true, but with equal certainty this result is not peculiar to scientific training, for it belongs to the laboratory method, and appears whenever the method is applied to any subject. It may be claimed that the most direct and tangible materials for observation fall within the province of science, but this is a difference of degree rather than of kind, and, therefore, the result may be obtained apart from science. It is true that in the elementary stretches of education the methods are still prevailingly conventional, and, therefore, stunt the natural powers of observation. The fine tentacles of inquiry which are put out in every direction by the child thus become atrophied, so that when later in his educational experience he is introduced into the laboratory he is as helpless as though transferred to a totally different set of life conditions. It takes almost a surgical operation to open his eyes, and he is apt to have lost not only the power, but with it also the desire of observation. This wholesale and criminal mutilation of natural powers, however, is not the fault of the subjects studied, but of the conventional methods employed, which demand faith rather than sight, memory rather than reason, the sacrifice of truth to conventional ideas. To keep these important powers functional may still be an important mission of science in elementary education, but when the conventional method has been replaced by the natural in all subjects of study, this mission also will have been fulfilled, and will be recognized merely as an incident in scientific training.

Those who are accustomed to look a little beneath the surface before formulating a statement are very apt to be content with saying that the study of science trains in the power of analysis. This is certainly getting the subject upon higher ground, and suggests a result which is worthy of every effort. The power of analysis is one of immense practical importance, and the value of its cultivation will not be denied. To imagine, however, that analysis is the ultimate purpose of science, is not to go very much farther than to say that the ultimate purpose is the laboratory method. The latter is the method, the former is but the first step in its application. But even this step is by no means peculiar to science, for it is the initial one in the teaching of every subject. In our search, therefore, for the peculiar benefits of science in education, we are again compelled to look further.

Beyond analysis lies synthesis, and this certainly represents the ultimate purpose of science. The results of analysis are as barren as a bank of sand until synthesis lays hold of them. It is just here that a large amount of science teaching fails, for to many teachers the accumulation of unrelated facts seems to be the end of scientific study, and the results of the laboratory may be represented by a chaotic pile of brick rather than some definite structure dominated by an idea. Almost anyone may accumulate facts, but to relate them, to distinguish the significant and the insignificant, to recognize that they are merely external expressions of something general, belongs to the highest stretches of scientific training. May I be permitted to say, without being misunderstood, that the potent influence of the German laboratories upon American establishments has resulted in general in making our best investigators and our worst teachers. The influence is beneficent to the last degree in so far as it lays hold of a disposition to careless work and hasty generalization and holds it down to the patient collection of facts and their very cautious collection; but when it results in mere Gradgrind teaching all inspiration has evaporated, and the laboratory touches no more the finer mental powers than does a factory. The difference indicated finds its illustration in some of our best known texts, which are merely expressions of styles of teaching. In the one case the facts are presented in the helter-skelter fashion, solid and substantial enough, but a regular mob, with no logical arrangement, no evolution of a controlling idea. Details are endless, no emphasis brings out certain things into prominence and subordinates others, and the whole subject is as featureless as a plain, where the dead level of monotony kills off every one but the drudge. It is the spirit of analysis, a dead body of facts without a vitalizing spirit. In the other case fewer facts are presented, but they are the important ones, and marshaled in orderly array, battalion by battalion, they move as a great whole toward some definite object. The facts may fade away, even the battalions may grow dim, but the great movement remains definite and clear as a memory which is an inspiration. Instead of a level plain, there are mountain peaks and valleys, there is a perspective and there are vistas from every point of view. This is the spirit of synthesis, which vitalizes the great body of facts and makes them glow. To the teacher, in his work of training, an unrelated fact is worse than useless.

But even synthesis is not peculiar to science. To pass by the incidental and temporary and reach the real and permanent contribution of science to education is to discover that it lies, not in teaching the laboratory method, in developing the power of observation, in cultivating the spirit of analysis, or even in carrying one to the heights of synthesis; but in the mental attitude demanded in reaching the synthesis. In this regard the demands of science are diametrically opposed to those of the humanities, for instance, using this loose term to express the great region of literature and its allies. The humanities have been and must continue to be a noble course of intellectual development, without which an education is certainly incomplete. It is the most ancient and best known form of culture, and being ancient and bound up with the intellectual development of mankind it must necessarily continue to hold high rank. The general effect of the humanities in a scheme of education may be summed up in a single word, appreciation. They seek so to relate the student to what has been said or done by mankind that his critical sense may be developed, and that he may recognize what is best in human thought and action. To recognize what is best involves a standard of comparison. In most cases this standard is derived and conventional; in rare cases it is original and individual; in no case is it founded on the essential nature of things, in absolute truth, for it is apt to shift. In any case the student injects himself into the subject; and the amount he gets out of it is measured by the amount of himself he puts into it. It is the artistic, the æsthetic, which predominates, not the absolute. It is all comparative rather than actual. The ability to read between the lines is certainly the injection of self into the subject-matter, and the whole process may be regarded as one of self-injection in order to reach the power of appreciation. My claim is that any education which stops with this result is an incomplete one, and that there is another mental attitude which is a necessary complement before a full-rounded education can be claimed; and that this complementary mental attitude is developed by a proper study of the sciences. If the study of nature is conducted so as to cultivate merely a sentimental appreciation of natural objects, it does not fall within the category I am considering, and can in no way be considered as a study which acts as a complement to the humanities. It is merely more of the same thing. If the proper intellectual result of the humanities is appreciation, whose processes demand self-injection, the proper and distinctive intellectual result of the sciences is a formula, to obtain which there must be rigid self-elimination. Any injection of self into a scientific synthesis vitiates the result. The standard is not a variable, an artificial one, developed from the varying tastes of man, but absolute, founded upon eternal truth.

Two such distinct mental attitudes as self-injection and self-elimination must receive attention in education, which cannot be complete without both. They are not contradictory, but complementary, and it takes both to make the "all-round" man. The exclusive cultivation of either one must result in a lop-sided development. Persistent self-injection tends to mysticism, a confusion of ideals or even vagaries with realities, a prolific cause of all irrational beliefs. Persistent self-elimination narrows the vision to a horizon touched by the senses and clips the wings that would carry us now and then beyond the treadmill of life into a freer air and a wider outlook.

The one needs the other as a check. In their combination self-injection is held back from dangerous flights by the demand to feel something solid beneath the feet; and self-elimination is compelled to raise its eyes now and then from the ground and sweep the heavens.

In our analysis, however, we strip off the flesh and lay bare the skeleton, and are apt to lose sight of the fact that the contour is a composite result. Although the skeletons of the humanities and of the sciences may differ from each other in the fundamental way described, I cannot conceive of the resulting contour of the one as distinct from combination with the other. The self-eliminating result of science must be associated with the self-injecting result of the humanities, even though science alone be studied; and the power of appreciation developed by the humanities must always be tempered by the scientific spirit. And yet, the two processes and the two results are so distinct and so complementary that any scheme of education which does not provide for the definite cultivation of these two mental attitudes, and which leaves the complementary part merely to the chances of methods of teaching and mental structure, is in constant danger of resulting in mental distortion.

I have indicated in this very general way the broad principles involved in the mission of science in education. Numerous details might be presented which would justify the claims that have been made, and perhaps such details would have made my thesis more clear, and would have left me in less danger of being misunderstood, but neither the time nor the occasion will permit them.

There is a factor of such overwhelming importance in the effectiveness of the mission of science in education that I cannot forbear the mention of it, and that is the teacher. I have presented the possible, the ideal results, but they can be approximated only by the thoroughly competent teacher. The problem of the teaching of science in the universities is becoming a serious one. There is no need to include in this discussion the teaching of science in the schools, for those engaged in it are devoting their whole time and knowledge to its development. It is sadly true that, as a rule, they need more time and far more knowledge, but this need is being gradually met, and every year the teaching in the schools is becoming better. On the contrary, I am tempted to say that every year the teaching of science in the universities is becoming worse. Perhaps the statement is too strong, but it expresses a tendency that must be checked. The university instructor is confronted by two serious duties; he is to instruct, and he is to produce. In the constitution of American universities the primary function of the instructor is to instruct; and if time and strength permit, the secondary function is to produce. From the theoretical standpoint production is essential to a thoroughly good university instructor, for production makes all the difference between a pump and a perennial spring. There is no special inspiration in the continual retailing of second-hand information. Practically, however, the conscientious teacher must expend all his energy, or at least all his effective energy, upon teaching and faculty duties. The logical outcome is that teachers who wish to investigate cease to be conscientious as teachers. Production becomes the principal thing, and instruction a mere incident. It might be expected that these unconscientious teachers would be gradually eliminated, but there are two facts which not only prevent the elimination but increase the evil. The first is that in large universities the tenure of office is practically unlimited, and if the instructor is making a name through production his tenure of office is not likely to be terminated, however bad his teaching. The second fact is that in the appointment of new instructors the universities to-day are looking more for productive power than for teaching power. This latter fact reacts seriously upon those who are preparing for university positions, and their whole training is upon problems connected with their subject to the entire exclusion of those connected with its presentation. In short, my claim is that in the universities our instructors have been trained to investigate rather than to teach. I have never met such wretched teaching anywhere as is daily permitted in the greatest universities. Under such conditions the instructor for a few years makes a spasmodic effort to teach, presently loses his interest in it, and gradually lapses into indifference. It is a common statement that large universities are no places for undergraduates, as they are turned over to the younger instructors and do not meet the heads of departments. Theoretically this is a serious charge, but practically it is a wise arrangement, for in general it is true that the undergraduate would do well to beware of the old instructor, unless it is his wish to be neglected. The instructor who is a novitiate will work hard for him, even to the point of drudgery, though he does not always work effectively.

I must not be misunderstood. Those who are born to teach will always teach when placed before a class, and every university has its share of such teachers, and the older they get, the more effective do they become; but I think I am right in claiming that the majority of instructors who have been brought into the universities within the last decade or two are teachers as an incident to investigation. I am not blaming these instructors, for I enter into their feelings most sympathetically. I am merely stating a problem which must be solved. We must have production or teaching will become a treadmill and real universities will have no reason for existence; but we must also have effective teaching. The problem is, how can we have both? The answer is simple, but hard of application, for it involves the natural limitations of men, which they are slow to recognize. Some are born to teach and some are born to produce, and these two classes should be recognized and utilized by the university, but self-recognition is more difficult. As it is, every instructor feels upon himself a pressure to produce, for it is in the atmosphere to-day; but in the majority of cases yielding to this pressure involves a waste of valuable time and energy without any adequate result. Such instructors are unwilling to acknowledge, even to themselves, that they have not the initiative for profitable investigation, whatever may have been their preparation.

On the other hand, the born investigator is nearly as slow to recognize that he is probably not a successful teacher. With born teachers trying to investigate, and born investigators trying to teach, and still others born to do neither, the average university becomes a good illustration of misdirected energy. If in any way the lines could be drawn so that the two classes could be recognized by themselves, as they already are by their associates, the problem would be solved.

In my judgment it would be fatal absolutely to restrict either to his own field, for the teacher, in his own interest rather than that of his subject, must produce enough to retain and develop his inspiration, and to appreciate the methods and results of investigation; while the investigator, in his own interest rather than that of his students, must teach enough to retain his breadth of vision and to cultivate the power of clear and apt expression.

In connection with any claim for the great and pecu-

* An address delivered at the annual commencement of the University of Michigan, June 21, 1900.

liar contributions of science to education, it seems pertinent to refer to a complaint heard now and then that the encroachment of science upon university attention has changed the atmosphere from one that is literary to one that is commercial. A common phrase is: "The commercializing tendency of modern education." The idea seems to be that a certain fine flavor of thought and expression is becoming less evident, and that the somewhat indefinite but soaring balloon is being replaced by the locomotive. Without calling attention to the fact that if one wants to get anywhere at any definite time the locomotive is more effective than the balloon, and without inquiring into the personal training or idiosynerasies of those who make the complaint, I wish to call attention to a probable explanation of the imaginary change.

The old education, which is reputed to have had such beneficent results, was a magnificent training; but it must never be forgotten that it was an example of extreme specialization. A narrow round of subjects was continually studied, and all that can be claimed for specialization appeared in the result. Like all specialization, however, its effective application depended upon the mental aptitude of the student. As these aptitudes are quite varied, the old specialized education selected from the mass the few to whom it was adapted, and these became really educated and dominated the university atmosphere, their more numerous fellows falling out unnoticed in the unequal race. And so the flavor which belongs to this special kind of education became the universal flavor of the educated.

When new subjects appeared and courses began to be multiplied, other students began to be selected from the mass and joined the society of the educated, and the old flavor ceased to be one peculiar to education in general.

The change, therefore, is simply that more students than formerly are reaching what may be called an education, and the difference is one of proportion, not of actual number. Opportunity for the old education is still with us, and those who are adapted still take advantage of it, and their number is greater than ever before. But they are compelled to acknowledge as brothers in the fraternity of the educated a host who had been excluded before through lack of opportunity. There is no longer an aristocracy in education, and the democracy of to-day demands that all who are trained, by whatever method, shall strike hands as brothers and equals.

In conclusion, may I be permitted to say that the full significance of scientific training will appear only when it begins in some form in the primary schools and touches the student at every stage of progress. Appealing as it does to the most natural tendencies of childhood, its greeting at the threshold of school experience is that of the one familiar friend, whose presence relates the young to things which they can see and handle, and saves them from that desolation of spirit and mental warping which comes from exclusive contact with the conventional and the intangible. The university owes a great service to the schools in this particular, and the tentacles of its influence must constantly be reaching delicately and inquiringly into school instruction. What the schools can do or cannot do, what they should do or should not do, are questions which cannot be answered in ex-cathedra fashion. The willful ignorance of many university instructors in reference to the work of schools upon which they depend is amazing. The university, as a whole, recognizes and encourages the intimate relationship, but only an instructor here and there interests himself in discovering the real situation. The result of this appears usually in requirements for admission, which are often adapted to some theoretical university position rather than to the possibilities of the modern American high school. In the debates upon these admission requirements a large faculty is apt to be divided, and the line of division usually separates those who know the schools and those who do not. If the latter be in the majority, the university is at once effectively handicapped. There is much talk of forcing schools to university standards, but this forcing is necessarily artificial and temporary if it runs counter to the inevitable tendencies which one who knows recognizes in the American school system. This system is more impregnable than the universities, for it is more extensive and better adapted to the peculiar conditions of American civilization.

It is only a question of time when every university will recognize the fact that it must adapt itself to the possibilities of the schools, and that ancient or artificial standards can be maintained only so long as they approve themselves to the experience of the schoolmaster. The mountain will never come to Mahomet. To compel schools to differentiate early a small and select and expensive class for entrance to the universities is unfair both to school and to the university, and seriously checks the diffusion of higher education. To deny the privilege of breathing the university atmosphere to any product of a good secondary school involves such a narrow conception of education that one dislikes to associate it with the university. It has always seemed an anomaly that universities are inclined to rate themselves more upon the basis of their raw material than their finished product. A fine-meshed screen is set up at the beginning of the university career, when it would seem far more logical to set it up at the other end.

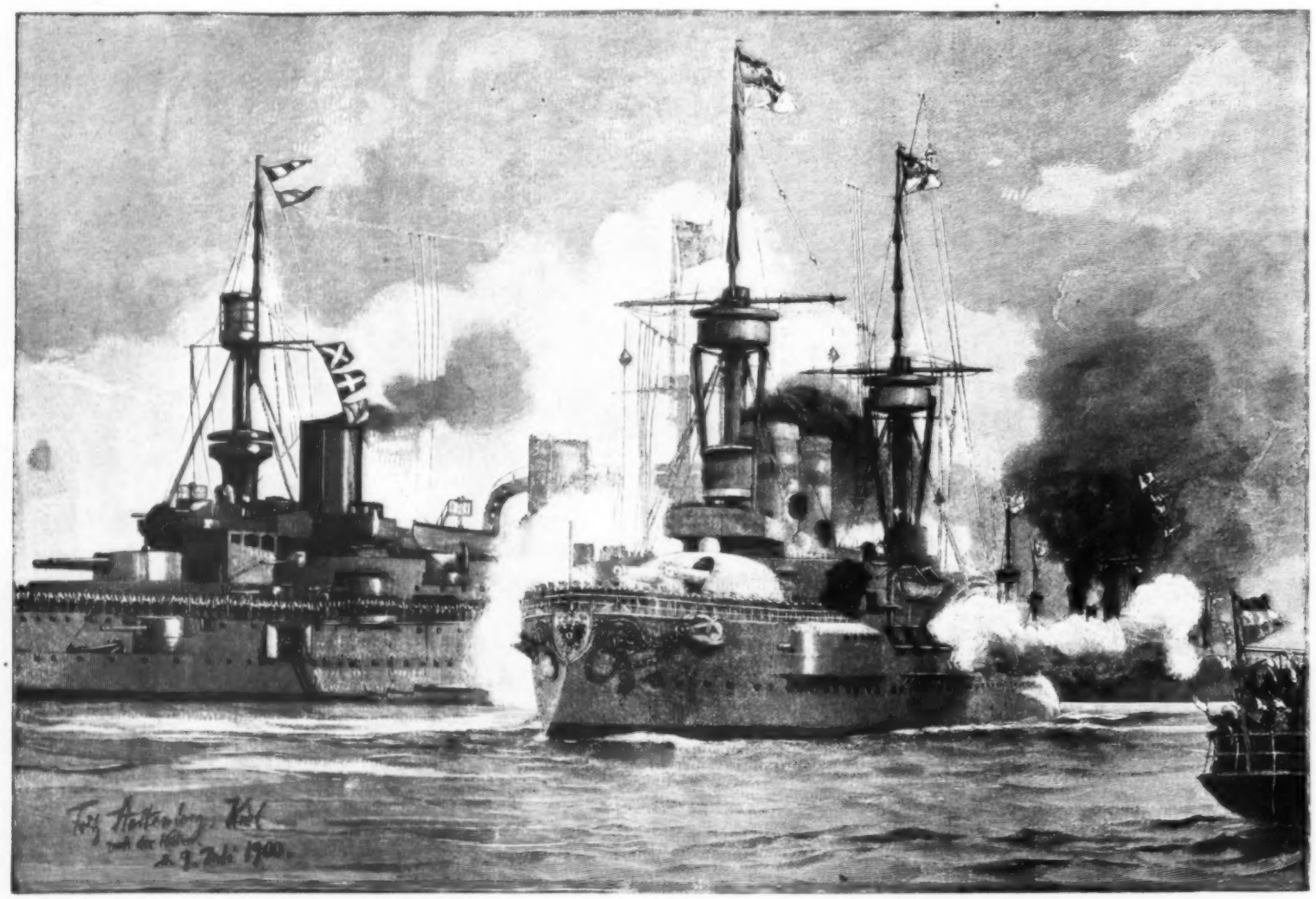
This matter of entrance has much to do with the opportunity given to science to express itself in education. If its most promising and best trained material is turned back or handicapped when attempting to enter the university, a certain kind of educational theory may command the result, but it is a blockade against the general progress of education, in so far as it cuts off a great agency from operating upon the legitimate material.

A statement summarizing the claims set forth in this paper may be formulated as follows: The introduction of science among the subjects used in education has revolutionized the methods of teaching, and all subjects have felt the impulse of a new life; it has developed the scientific spirit, which prompts to investigation, which demands that belief shall rest upon a foundation of adequate demonstration, which recognizes that the sphere of influence surrounding facts may be speedily traversed and that everything beyond is as uncertain as if there were no facts; it has introduced a training peculiar to itself, in that it teaches the attitude of self-elimination, an attitude necessary in order to reach ultimate truth, and thus supplements and steadies the other half of life, which is to appreciate. To obtain these results there must be teachers who can teach, whose background and source of supply is the investigator. Moreover, the results are immensely desirable, inasmuch as they do not interfere with anything that is fine and uplifting in the old education, but simply mean that the possibilities of high attainment and high usefulness are open to a far greater number.

THE GERMAN SQUADRON IN CHINA.

ON the last day of June the armored cruiser "Fürst Bismarck" sailed for China. A week later she was followed by the gunboat "Luchs." Two days after the departure of the "Luchs," says the Illustrirte Zeitung, the remaining ships detailed for service in Chinese waters sailed away with a ceremonious farewell from the Kaiser. This last squadron was composed of the four large battleships "Kurfürst Friedrich Wilhelm," "Brandenburg," "Weissenburg," and "Wörth," and the cruiser "Hela."

The vessels formed the first division of the first squadron, and were about to proceed to the Baltic Sea when the order came to prepare for China. The com-



THE GERMAN SQUADRON LEAVING KIEL FOR CHINA.

mander of the squadron, Vice-Admiral Hoffman, immediately returned to Kiel, at which port the ships arrived on July 4. On July 7 Vice-Admiral Hoffman hauled down his flag from the "Kurfürst Friedrich Wilhelm" to give place to that of Rear-Admiral Geissler. The crew of 556 men for each of the 10,000-ton battleships was increased to 700 men. Swarms of workmen labored day and night stowing away provisions, installing ice machinery, and such auxiliary apparatus as a long cruise in the tropics rendered necessary.

On the Sunday before sailing day Chaplain Heim held a service on board the flagship. After service the Kaiser came on board in order to inspect the ship and to impress upon the men the full importance of the enterprise on which they had embarked. On the 9th the division lay in the stream, ready to sail. The Kaiser left the royal yacht "Hohenzollern" and transferred his flag to the "Kaiser Wilhelm II." At eight o'clock the "Hela" got under way, and was followed at intervals of one-half an hour respectively by the "Wörth," "Weissenburg," "Brandenburg," and at ten o'clock by the "Kurfürst Friedrich Wilhelm." The ships were bedecked with flags and the crews lined the railing and exchanged cheers with the men on the ships that remained at home. As each vessel passed the "Kaiser Wilhelm II." a thundering hurrah arose, the bands played, the flags dipped, and the guns saluted. On the bridge of the "Kaiser Wilhelm II." stood the Kaiser waving a final farewell to the departing fleet.

The ships are now at Hong-Kong, China, and will probably remain there for some time to come. The "Wörth," however, has been sent north to Taku.

AMERICAN TRADE AND SHIPPING.

THE rapid growth of the foreign trade of the United States is a subject to which attention has already been drawn in our columns. The returns for the fiscal year ended June 30 last give occasion for another reference to the subject, the more especially as another record has been created, and as, associated with these returns, there are points of considerable interest in the United Kingdom. The total value of the merchandise imported and exported in the twelve months was $2,244,193,543, compared with a previous best of $1,924,520,818 for the immediately preceding year. For 1894-95 the aggregate did not exceed $1,593,508,128, so that the increase in five years has been as much as 45 per cent., a rate of progress which has never been paralleled in the history of the United States, and very seldom, we should imagine, in the history of any other nation. To facilitate a comparison with some previous years, and to show what is the measure of the "trade balance" in favor of the United States, we give the following table:

Year Ended June 30.	Imports.	Exports.	Excess of Exports.
1894	$654,994,622	$892,140,502	$237,145,950
1895	781,969,963	807,538,165	75,568,200
1896	779,724,674	882,606,938	102,882,264
1897	764,730,412	1,050,993,556	286,263,144
1898	616,052,844	1,231,311,868	618,259,024
1899	697,077,388	1,227,443,425	530,366,037
1900	849,714,329	1,349,479,214	544,764,885

On the one year, it will be seen, there is an increase of $152,636,541 in imports of merchandise, and an increase of $122,036,789 in the total of exports. It is pointed out that among imports the class which shows the most material improvement is that which comprehends "articles in a crude condition which enter into the various processes of domestic industry." Manufactures show a gain of about $20,000,000 in one year; articles of voluntary use, luxuries, etc., also about $20,000,000; articles of food, about $15,000,000; articles wholly or partially manufactured for use in manufacturing, $25,060,000; and articles in a crude condition, over $75,000,000. This figure is an eloquent comment upon the spread of American manufacturing industries.

It must always be remembered, of course, that the past year was marked by a very high range of prices all round, and this naturally makes the figures look all the more favorable; but the actual movement was phenomenal, and the general prosperity no less remarkable. Among exports, while the great staples kept up well, the feature was the increase in exports of manufactured articles, which rank for a round $425,000,000. Of this total again, about 25 per cent. represents shipment of metal and manufactures thereof. Gains of from 20 to 40 per cent. were made in exports of steel rails, structural iron, steel wire, builders' hardware, electrical machinery, agricultural implements, locomotive machinery, and iron pipes and fittings.

The two largest items of manufactures exported by the United States for the year 1900 were copper ingots, which rose in value to the enormous sum of $55,722,000, and refined mineral oil, which was valued at $67,740,000. This increase in value, both in copper and oil, may have been due more to advances in price than to enlargements in exported materials, but the defective methods of classification pursued by the Treasury Bureau of Statistics make it impossible to say whether this is so, or if not, what has been the actual expansion on the basis of quantity. The same defective methods prevent us from verifying the assertion that in 1899-1900 America exported in value a great deal more in the way of manufactured goods than it imported. This may have been the case; but it should be remembered that goods that are classed as manufactured goods in the exports returns are sometimes classed as crude commodities in the import returns, and there is apt to be confusion.

In the table given above we have shown that for several years past there has been a large apparent balance in favor of the United States. The net indebtedness, however, is nothing like the amount implied by the figures. Assuming that there has been no overvaluation of exports, there are several ways in which the balance is reduced. The cost of carrying the merchandise that leaves the country or comes to it by sea is very great, and as America has been practically driven out of the shipping trade, this money goes chiefly to foreign shipowners. All that part of this charge which is paid by America enters, therefore, into the account as an offset to the merchandise credit balance. There has been a large return of American railroad securities to the States during the last eighteen months or so, investors here having at last learned to sell American securities when they are high and to buy them when they are low.

Then, again, there is the interest payable on European money invested in American industrial undertakings of various sorts. This represents a very appreciable sum annually; and another large contribution to the balancing of the account is made by American visitors to Europe. They carry letters of credit drawn on European banking houses. The money they spend is a debit entry in the account with the United States, diminishing by just that much the sum owing to it on account of the export balance. Further, in recent years Europe has become a considerable borrower of American money. Instead of demanding a cash settlement from his European consignee, which would involve the shipment of gold, the American shipper of merchandise sells a bill of exchange for the amount to a banker who is then entitled to draw on London for his due. If the money rate happens to be low in New York and higher in London or elsewhere in Europe, the banker lends the money for what interest he can get. There is reason to believe that the amount of American money loaned in London has, during the past two or three years, been very large. In the past six years the export surplus has reached a sum equal to about £400,000,000, of which something like £350,000,000 can be accounted for by the causes enumerated, leaving about £50,000,000 on loan, because interest here is higher than in New York. Just now, for instance, loans in that city are quoted at 1¼ per cent., while in London they range between 2 and 3 per cent., and occasionally go still higher.

It is an anomaly that only 9 per cent. of the total foreign commerce of the United States is carried in American bottoms. The reason is too well known to need recapitulation at this late date. But the condition of the country's shipbuilding industry is improving, and when the subsidy law is passed, as it will no doubt be in the next session of Congress, we may look for a revival on a large scale. It is a well-known fact that builders are only waiting for the enactment of this measure to show what they can do. The report of the Commissioner of Navigation states that the additions of American-built ships to the country's merchant marine during the past fiscal year have been greater than during any previous year since 1856. The vessels built have a tonnage of 381,863 tons. This was exceeded once (in 1874) by 50,000 tons, but canal boats were then counted in, and now they are not. Of the entire new tonnage, 483 vessels, of 213,052 tons, were steam vessels. It is true that only a slight addition was made to the tonnage designed for the foreign trade, and that, allowing for losses, there is a slight net decrease in this branch; but indications point to an unmistakable change before long. In the nine months to April last many shipbuilding plants long closed were reopened for business, and ten companies proposed the establishment of new plants to cost [redacted] $500,000 each and ranging to $6,000,000. The American tonnage now in process of construction will [redacted] an aggregate value of nearly $30,000,000. A year ago it was only two-thirds of this amount. These figures refer to tonnage destined for commercial purposes, and do not include the large number of naval vessels under construction on government account. Among the yards recently established, or much enlarged, may be mentioned that at Newport News, where $12,000,000 is invested; the new plant at Camden, which will cost $6,000,000; the Cramp Works, and the Union Works at San Francisco; the Sparrow's Point yard, near Baltimore—started ten years ago and recently equipped with new machinery—where important work is in progress; the adaptation of the works at Bath, Me., to the building of steel vessels; the new yard in New London, Conn., where vessels of the largest class are to be constructed; and the new yard at Richmond, Va. In all these, we are assured, the equipment is of the first class, and full advantage has been taken of the inventive genius of the American engineers and machinists in devising labor-saving machines and appliances. Of course, the demand for vessels of the mercantile class depends upon the prosperity of trade and commerce in a general sense. It is apparent that shipbuilders are expecting a long continued demand for the product of this industry. They are not lightly or carelessly investing so much capital in enterprises that promise no reward; but they will be pleased to have the subsidies which a paternal government proposes to distribute among them.—London Engineering.

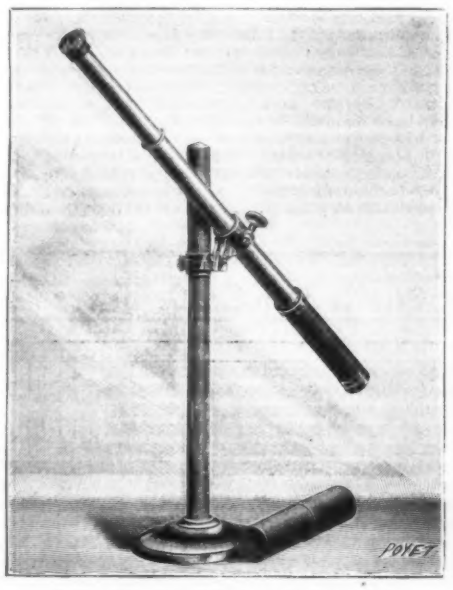


FIG. 1.—THE TELEMICROSCOPE.

A SIMPLIFIED TELEMICROSCOPE AND SOLAR MICROSCOPE.

THE magnifying instruments, lenses and microscopes, that are usually employed for natural history researches present two great defects, viz., they embrace but a very limited field, and their very short focal distance necessitates a very accurate focusing that renders a study of living animals almost impossible. We have more than once heard naturalists complain of not having at their disposal a good lens that would permit them to examine at leisure insects freely engaged in their usual occupations, and that, too, from such a distance as not to disturb them.

M. l'Abbé Deschamps, a priest of Perigord and former professor of physics, has recently supplied this long felt want in the devising of an arrangement which greatly amplifies the field and very notably increases the focal distance without prejudice to the magnification, which, at 10 inches, is 12 diameters. The instrument, which is called a "telemicroscope," is, in principle, nothing more than a spyglass of a special kind. Its objective is composed of two achromatic lenses that are separated by a distance less than the principal focal distance of the most convergent lens, and, therefore, act like a single one. This arrangement increases the achromatism and permits of obtaining very sharp images.

A Dollond ocular with four plano-convex lenses completes the optical system. The eyeglass has been made as convergent as possible in order to increase the magnification and the field without diminishing the definition.

Thanks to this instrument, it is possible to observe insects occupied in their work from a distance great enough to prevent them from being disturbed.

The telemicroscope is capable of rendering no less service to the botanist, who may sometimes find it of interest to be able to observe a plant in its entirety at a magnification of from five to six diameters. We may add that the instrument, owing to its focal length, embraces with the same sharpness several unequally distant planes, thus giving the eye a remarkable impression of relief, comparable to that furnished by a good stereoscope.

Along with the telemicroscope M. Deschamps has devised various modifications of the solar microscope which render its manipulation easier and its utility much greater. The first simplification is in the method of maneuvering the mirror, which is moved without gearings by means of a handle and a wire that passes through a rubber disk. The handle controls the motion in a lateral direction, and the wire in a vertical one. Moreover, the objective may be focused with accuracy without the aid of a micrometric screw. The diaphragm is fixed to the objective. Finally, all the movable parts slide upon a bar upon which they may be rendered immovable at the proper points through set screws. But the most important improvement in the apparatus resides in the elimination of the heat. We know that if we place living animals upon the object glass of the ordinary solar microscope, they will be roasted in a few seconds. It has hitherto been possible to remedy this inconvenience only in a very small measure, and that by interposing troughs of water or a solution of alum designed to absorb the heat in part. Now the arrangement of the lenses alone in the new system permits of obtaining such a result with a maximum of utility. The diameter of the condenser is so selected as to give sufficient light without an excess of caloric. Besides, the focus is replaced by a system of two non achromatic lenses of equal focal distance, separated from each other by a space equal to such distance.

This system is placed, relatively to the condenser, at a point such that there forms an elongated focus upon the line of which there is no point at which the luminous ray converges integrally. Moreover, the combination of lenses forms a prism, deflects the rays of the infra-red (burning rays), maintains them at the periphery, and forms a white light at the point at which the object to be studied is situated, the heat being sufficiently eliminated to cause no injury to the living animals.—La Nature.

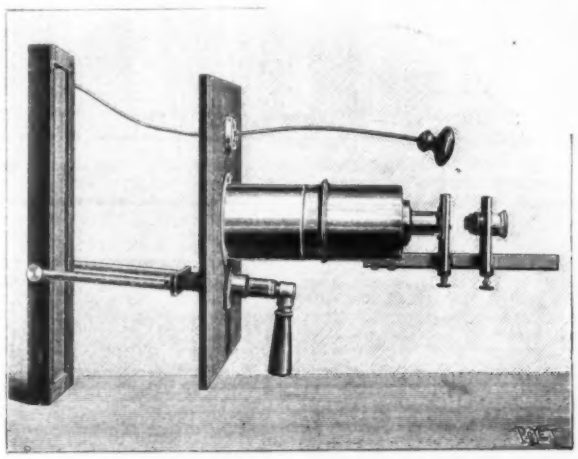


FIG. 2.—MODIFIED SOLAR MICROSCOPE.

The largest and finest elephant tusks ever obtained in any part of the world were recently sold at Zanzibar. The tusks were perfect in shape and perfectly free from disease. They measured 10½ feet from top to base, and scaled 239 pounds and 224 pounds respectively. They were sold for $5,000.

THE COAL TRADE OF THE UNITED STATES AND THE WORLD'S COAL SUPPLY AND TRADE.*

OUR modern industrial system is so closely dependent upon an adequate supply of mineral fuel that any disturbance of normal conditions in the coal trade reacts immediately upon the general state of industry. The past year, while showing a total output of probably not less than 775,000,000 net tons of coal, the largest amount ever produced and an increase over the preceding year's figures of 5 to 6 per cent., has witnessed, however, a considerable rise of price of this article nearly all over the world. An attempt to explain the cause of this rise of price is made in a subsequent chapter of this study. This higher price of coal was painfully felt not only by the domestic consumers but also by the industrial world at large. In some cases the difficulty in obtaining adequate coal supplies proved so enormous that factories and workshops had to close with large orders on hand. In this country the greater demand for coal, due, as in Europe, mainly to a general revival of industry, taxed to the utmost existing transport facilities, causing a general rise of freight rates. However, in view of the enormous output of last year, which is estimated at no less than 258,539,650 tons net, an increase over the preceding year's of about 38,500,000 tons, or over 17 per cent., the United States was the only great industrial country in which the available coal supply proved adequate to meet the extraordinary demand for its industrial and domestic consumption.

The figures showing the total output for last year are the largest on record in the history of coal production, not only of this but of any other country in the world. For the first time the United States figures show a larger production than the British figures for the corresponding period. The significance of this fact can not be overestimated. Coal is now more than ever "the material energy of a country, the universal aid, the factor in everything we do." The relative abundance or scarcity of coal, therefore, is the truest index of a country's position among its industrial rivals. According to recent information, steamers have been chartered to carry coal from America to St. Petersburg and Stockholm, as well as to Italian, French, and German ports. While these exports may be due mainly to the present abnormal conditions of the British coal market, there is no doubt that in time this country will be called upon to supply an ever larger part of the coal needed by foreign industrial countries, which, until recently, have been drawing upon the British output. This is the more probable since cost of production and price of coal show a falling tendency for this country, whereas the opposite holds true of European coal-producing countries.

Under these circumstances a study of the world's production and consumption of coal and the conditions of the coal trade in this country presents special interest.

One of the most characteristic features of modern industrial development has been the rise of the coal industry. Modern society relies upon coal as the fuel and source of power, and the terms iron age, machine age, and age of steam may all be translated the age of coal.

The rapidity with which the production of coal has increased may be appreciated when we consider the present volume of that production and reflect in how recent a time the production formed but a very small fraction of that quantity. In 1896 the total coal production of the world was 664,000,000 short tons or 604,000,000 metric tons. Until as late a period as 1878 the world's production had never been half so great, being only 292,000,000 metric tons in that year,* and not until 1868 had the world's production been as much as a third as large as it is at present. By 1864 the world's production was only 174,000,000 metric tons, or less than 29 per cent. of the production of 1896.

The statistics of the world's production for still earlier periods can not be determined with any pretense of accuracy; but on the basis of the British statistics from 1854, and of estimates for earlier periods, and from such statistics as are obtainable from France, Germany, Belgium, and Austria-Hungary, an approximation may be made to the actual production. In 1860 the world's production of coal† was about 142,000,000 long or 144,900,000 metric tons, or less than one-fourth of the production of 1896, and considerably less than the production of either the United Kingdom or the United States at present. Ten years earlier the world's production amounted to only about 83,000,000 metric tons, about two-fifteenths of the present world's production and considerably less than the present output of the single State of Pennsylvania. In 1840 the production was much smaller still, amounting to little over 45,000,000 metric tons, or about one-thirteenth of the present output, while during the three-quarters of a century since 1820, when the output was but about 17,000,000, the production has increased about 3,500 per cent.

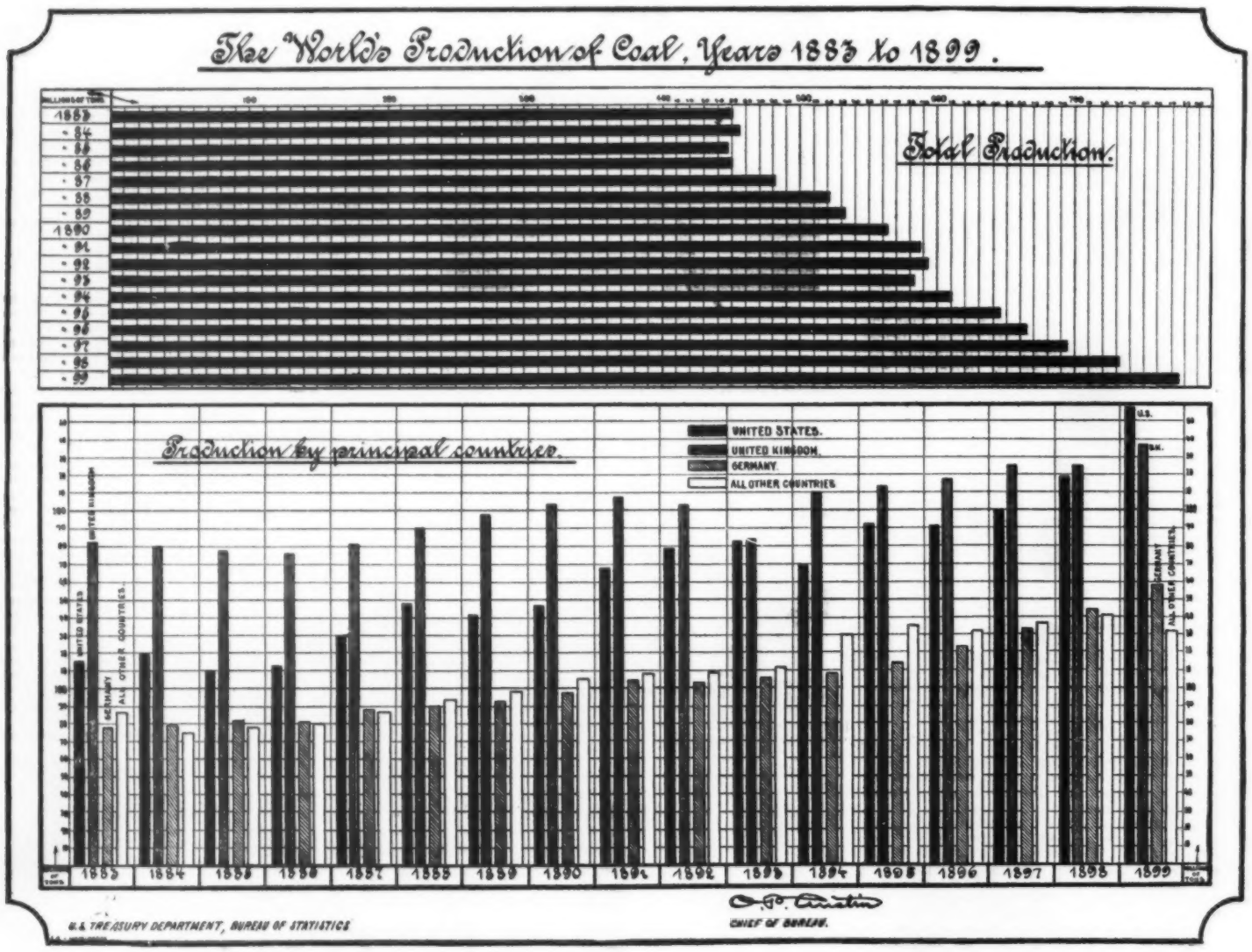
While the figures for the world's production prior to 1864 are necessarily defective, owing to the absence of accurate statistics for the English and American industry, they sufficiently indicate the immense development of the industry during the present century. The significance of this development can not be overlooked.

The production of coal is chiefly in the hands of three nations, the British, the Americans, and the Germans. During the last thirty years, and even earlier, the combined coal output of these three countries, the United Kingdom, the United States, and Germany, has averaged year for year about five-sixths of the coal output of the world. Possessing but a tenth (about 10 per cent.) of the population of the world, they have produced about 83 per cent. of the mineral fuel, while the remaining 90 per cent. of the world's inhabitants have produced only about 17 per cent. of the coal: and even if the savage and semi-barbarous nations be disregarded, the immense preponderance of coal production in these countries must be conceded. To this group might be added Belgium, which produces and consumes more coal per capita than any other country except the United Kingdom, but for the fact of its small population, placing it in the second rank of coal-producing countries.

While the continued output of these three countries has kept pace with the production of the rest of the world, their relative position has been materially altered. In 1868 the United Kingdom produced over three times as much as either the United States or Germany, the output of these countries being approximately 52, 14½, and 16½ per cent. of the world's production, respectively. In 1870 the proportion was about the same, although the United States had gained upon Germany as a coal producer. By 1875 the output of the United Kingdom was still considerably greater than the combined production of the United States and Germany, the output of these three countries forming 45, 20, and 18 per cent. of the world's production, respectively. The next half-decennial period witnessed a remarkable increase in the American production and a corresponding relative decrease in that of Great Britain, the proportion of these countries being 36, 28, and 17 per cent., respectively. This increase was maintained during the present decade, and in 1896 the output of Great Britain and Ireland was only 34 per cent., that of the United States already 30 per cent. and that of Germany 19·2 per cent. of the coal production of the world.

These statistics clearly show that the United Kingdom is rapidly losing its former pre-eminence as a coal-producing power, and that while its production is increasing rapidly, its absolute increase is less than that of the United States, and its relative or proportional increase considerably less than that of either the United States or Germany. In 1868 the production of these three countries, the United Kingdom, the United States, and Germany, in the order named, was 115,500,000, 31,600,000, and 36,200,000 net tons; in 1897 their output was 226,400,000, 200,200,000, and 132,700,000 of net tons, respectively. The absolute increase in the British production was 110,900,000, as compared with 96,500,000 for Germany and 168,600,000 net tons for the United States. The proportional increase during these three decades (1868–1897) was 96·4 per cent. for the United Kingdom, as compared with 266·1 per cent. for Germany and 532·3 per cent. for the United States. The average annual rate of increase was 2·33 per cent. for the United Kingdom, 4·60 per cent. for Germany, and 6·64 per cent. for the United States.

The countries in the second order of coal production are Austria-Hungary, France, and Belgium. These countries produced in 1896, 84,200,000 metric tons of coal, or 14 per cent. of the total. The combined output of these countries is thus considerably less than that of Germany, and less than half of that of either the United Kingdom or the United States. The coal production of these three countries has increased at a rapid and fairly constant rate, but the increase for Austria-Hungary has been more rapid and recent than that for the other countries. In 1830 Belgium produced 1,900,000, and Austria-Hungary but 200,000 metric tons; in 1840 Belgium produced 3,900,000,



* Abstract from the Summary of Commerce and Finance, for April, 1900. Bureau of Statistics, Treasury Department.

* Short ton, 2,000 pounds; metric ton, 2,204 pounds; long ton, 2,240 pounds.

† According to Mulhall.

France 3,000,000, and Austria-Hungary but 500,000 metric tons; by 1859 the output for these countries was 5,800,000, 4,500,000, and 1,100,000, respectively; by 1860, 9,600,000, 8,300,000, and 3,500,005; 1870, 13,700,000, 13,300,000, and 8,400,000. During the next decade the production of France begins to exceed that of Belgium, passing it in 1873 and remaining larger ever since, and the output of Austria-Hungary gains upon that of Belgium. By 1880 France produced 19,400,000; Belgium, 16,900,000; and Austria-Hungary, 14,800,000 metric tons. From this time on the increase in the production of Austro-Hungarian coal was very rapid, in 1885 the output exceeding that of either France or Belgium. Since 1885 the output of Austria-Hungary has annually exceeded that of France as the production of the latter country has exceeded that of Belgium. In 1890 the production of these countries in the order named was 27,500,000, 26,100,000, and 20,400,000; in 1896, 33,700,000, 29,300,000, and 21,200,000 metric tons.

The rapidity of the development of Austro-Hungarian mines may be seen from the following statistics: From 1866 to 1896 the coal output of Belgium increased 66·06 per cent., that of France 144·30 per cent., and that of Austria-Hungary 588·16 per cent., the annual average rate of increase being 1·70, 3·02, and 6·64 per cent., respectively.

The six countries hitherto named—the United Kingdom, United States, Germany, Austria-Hungary, France and Belgium—are the only countries which at present deserve detailed consideration. The rest of the world has only about one twenty-fifth of the world's production, or about one twenty-fifth as much as the six countries named. Russia is seventh in the order of coal production, with a total in 1896 of 9,229,000 metric tons, or 1·5 per cent. of the total. The output of Russia, however, has rapidly increased, having more than quintupled since 1875, and being over thirteen times as great as that of 1870. Japan is eighth in the order of production, with 4,849,000 metric tons (1895), or 0·8 of 1 per cent., but the output is increasing rapidly. New South Wales, with 4,500,000 metric tons (1897), or about three-fourths of 1 per cent., is also rapidly increasing its production. India (1896) ranks tenth, with 3,900,000 metric tons, or two-thirds of 1 per cent.; and Canada eleventh (1896) with 3,400,000 metric tons, or 0·6 per cent. Other coal-producing countries are Spain (1,939,400 tons, or 0·3 per cent., in 1897) and the South African Republic (1,600,000, or 0·3 per cent., in 1897); and small quantities, always less than 1,000,000 tons, are produced in several other parts of the world, such as Sweden, Italy, and the several Australasian colonies.

GROWTH OF THE COAL INDUSTRY IN THE UNITED STATES.

The beginning of coal production in the United States dates back only to the first quarter of this century, although the existence of coal was noticed by the early explorers at the end of the seventeenth and the beginning of the eighteenth century. The Virginia deposits near Richmond, first noticed in 1701, were the first mines to be regularly worked in this country. Mining was begun there about the year 1750, and the coal was sold at Richmond in 1766 for 12d. (24 cents) per bushel, and at Philadelphia in 1789 for 1s. 6d. (37 cents) per bushel of 76 pounds. In 1822 the amount of coal mined in this region was 48,214 long tons; in 1833, 142,587 long tons. About the year 1820 the development of the anthracite coal regions began. Owing to the fact that the companies which first produced this coal were also building the first canals and railways, the growth of the anthracite coal trade proceeded more rapidly than that of bituminous coal. Until about 1870 the production of anthracite was greater than that of bituminous coal. Thus for the year 1860 the output of bituminous coal is estimated by the United States Geological Survey at 8,000,000 long tons, while the combined production of the Pennsylvania anthracite regions exceeded 8,500,000 tons, and for the year 1864 the average price of bituminous coal at New York was almost $1 per ton higher than that of anthracite—$7.68 as against $6.75.

It was not until coal began to be used extensively in the iron industry and the railroads made possible the transportation of coal for longer distances during all parts of the year that the production of coal, and bituminous coal more particularly, received its chief impetus. Although in Great Britain the use of coal for iron smelting dates back to the eighteenth century, the use of charcoal having been completely discarded at the beginning of the nineteenth century, the only fuel used in American blast furnaces until about 1840 was charcoal. This was quite natural, as with the abundance of large forests the charcoal used for the manufacture was relatively cheap, and transportation of charcoal was less difficult than that of coal. The introduction of anthracite and bituminous coal in the manufacture of pig iron created a revolution in the whole iron industry of the country. Facilities for the manufacture of iron were increased; districts which had been virtually closed to the manufacture because of a local scarcity of charcoal were now opened to it; production increased on a large scale, causing cheapening of prices and growing consumption.

Of the two forms of mineral fuel, anthracite was the first to be largely used in the iron industry, and it was only at a comparatively recent period that the relative popularity of the two kinds of fuel for blast furnace use has been reversed.

The year 1855 marks the passing of charcoal by anthracite in the production of pig iron, in the year 1869 the use of bituminous coal overtakes that of charcoal, and in 1875, also that of anthracite. The decline of anthracite as an agent in the production of iron becomes still more apparent if it is borne in mind that "some of the iron, classed as having been produced with anthracite and bituminous coal, respectively, was produced with a mixture of this fuel, the quantity so produced being represented mainly in the anthracite column." But even on its face the figures show incontestably that the anthracite coal has been superseded by the cheaper material. Thus the share of anthracite in 1880 was 42 per cent., in 1885 about 32, in 1890, 24 per cent.; in 1895, about 13·5, and in 1898 only a little over 10 per cent. In the table showing the total production of pig iron for 1899 the old-time division according to fuel used is entirely dropped, as having now little or no meaning. It is stated that the great bulk of iron is made with coke, and that the so-called anthracite furnaces use a mixture of anthracite coal and coke, the tendency being to diminish continually the proportion of anthracite.

The other great factor which caused the remarkable growth of the bituminous-coal industry was the rapid growth of the railway system in this country, especially after the civil war. The building of railways, interrupted by the civil war, proceeded, as is well known, at a most rapid rate during the last years of the sixties and the decade beginning with the year 1871. From a little over 35,000 miles in 1865 the number of miles of railroad constructed and operated rose to over 103,000 miles in 1881, and over 170,000 in 1891; i. e., had almost trebled within the sixteen years, and grown fivefold within a quarter of a century. The effect of this development on the Eastern and Central coal-producing States (Pennsylvania, Ohio, Indiana, and Illinois) was twofold. First, by increasing the demand for iron as material for the construction of the railways, thus adding to the existing demand for coal; and, second, by opening opportunities and outlets to the shipment of coal westward, both for use of the railways themselves and the various industries that sprang up with the advent of the railways. Coal constituting the largest item of expenditure in railway transportation, especially in this country, where distances are greater than anywhere in the world, the railways became naturally interested from the very beginning in obtaining their fuel at the cheapest possible price. This explains the close connection of the growth of our railway system with that of the coal industry during the past three decades.

The railways fostered by all possible means the development of adjacent coal regions, the more so that normally coal constitutes the most important article of traffic. Thus, according to the data of the Census of 1890, there were transported 184,300,000 of tons of coal (73,000,000 of anthracite and 111,300,000 of bituminous) out of a total tonnage of 640,500,000 carried; in other words, 28·8 per cent. of the total freight traffic on railways was furnished by coal, and 17·4 per cent. by bituminous coal alone. The community of interests often changed to identity in cases where the railway companies began to own and operate the mines of the regions through which they passed, thus securing for themselves the double profits of the operator and carrier. Apart from the Pennsylvania anthracite fields, which are now practically controlled by eleven powerful companies, nearly all of which engage both in mining and transportation, this development took place mainly in the West. Mines were said to be controlled by the Atchison, Topeka and Santa Fe in Kansas and Colorado, by the Union Pacific in Wyoming, and by the Northern Pacific near the western coast. In the older States, the Illinois Central, the Chicago and Alton, the Chicago and Rock Island, and the Wabash Railway companies were reported as being interested more or less directly in the mining operations. Sometimes, as in the case of the Chesapeake and Ohio Railway in West Virginia, the transportation company engaged in marketing the product, purchasing the coal mined along its line, and paying the operators a certain price agreed upon, the difference between the price paid to the operator and that charged to the consumer constituting, so to say, the freight charges. (Mineral Resources, 1894–95, p. 204.) At times the railways find it more profitable to transfer the direct control over their mines to a lessee for a number of years, stipulating only the purveyance of a certain amount of coal for their own uses at a certain privileged price. Thus, during 1896 an arrangement was perfected between the Atchison, Topeka and Santa Fe Railroad Company and the Colorado Fuel and Iron Company by which the former leased to the latter all of their coal mines in Colorado. The same took place in Kansas, and it was announced at that time that the railroad had retired from the coal-mining business. (Mineral Resources, 1896–97, pp. 474, 529.)

The impetus given to the mining of coal by the growth of railroads, as was mentioned before, was twofold in its nature. It was partially due to the improved facilities for movement, and consequently its greater cheapness, and secondly to the demand for iron and steel. The growth of the iron and steel industry, however, has acted in many other ways in stimulating a demand for coal. In many departments of industrial activity a revolution has taken place by the substitution of iron and steel for wood and other articles. Thus, in shipbuilding, wooden vessels are rapidly becoming of smaller and smaller importance, while steel and iron vessels are taking their place. In the construction of buildings a similar development has taken place, and steel and iron have taken the place of other structural materials. The immense strides in the structural-steel industry have rendered this form of building material cheaper, especially in view of its durability, than other material for the construction of large buildings.

The number of articles for which iron and steel are now being used is too great to permit of individual instances, but the importance of the entire movement, especially in its effect upon an increased demand for coal, is apparent. Even on the railroads the same development which has taken place from wood to iron and iron to steel in the evolution of the rail is now taking place in the evolution of the car, and iron and steel are completely displacing the wood of the old cars. At present the steel cars, which now average 50 tons capacity, are found to be not only cheaper, in view of their greater durability, but are also far cheaper in operation, owing to the fact that in proportion to their capacity their weight is considerably less than that of the old cars which they superseded.

This development, however, has led not only to a large increase in the demand for coal, but also to a disproportionately large increase in the demand for bituminous coal. In a certain sense, anthracite may be said to have been superseded as completely in the manufacture of iron as has charcoal. Thus, as late as 1880, the amount of iron manufactured from anthracite was almost as great as that manufactured from bituminous, there being 1,808,000 tons of iron made from anthracite as compared to 1,950,000 tons made from bituminous; while in still earlier periods—in 1855, for instance—there was six times as much iron made from anthracite as from bituminous. This state of affairs, however, has completely changed, especially since the recent great advances in iron and steel manufacture; and while the amount of iron manufactured from anthracite coal has declined to 1,348,000 tons, the amount manufactured from bituminous coal has increased to 12,007,000. This vast increase has naturally led to a rapid increase in the exploitation of the bituminous mines and to a corresponding mining activity in the respective regions.

This change has been largely due to the use of coke. The development of the coking industry in the United States has been remarkable in every sense of the word. Certain coals of the United States, especially those in the Connellsville region in Western Pennsylvania, are remarkable for their coking qualities, and the development of the art of coking has been rapid and complete. It is not within the province of this paper to discuss in greater detail the various processes in vogue for the economical coking of coal.

THE GEOGRAPHICAL DISTRIBUTION OF COAL IN THE UNITED STATES AND THE CENTER OF COAL PRODUCTION.

Since the beginning Pennsylvania has been the "Keystone" State for the production of coal, and the mining of this valuable material has centered in this region. Both in anthracite and bituminous Pennsylvania has always been in the lead, and this precedence has been maintained to the present time. The Pennsylvania mines are a part of the great chain which follows the Appalachian Mountain system, but in no part of the country, or in fact of the world, are the mines so famous or so rich as in this State. In the following figures the distribution of the coal mining industry among the various States will be followed for the last twenty years only. During this period there has been an immense development of the mining industry, the output of anthracite increasing from 28,600,000 tons in 1880 to 53,900,000 tons in 1899, while the output of bituminous increased from 38,200,000 to 177,000,000 gross tons.

The production of anthracite may be said to have taken place entirely in the State of Pennsylvania. While there has been from time to time production of anthracite on a small scale in Rhode Island, Virginia, Colorado, and New Mexico, the production in those States has never amounted to more than about one-fifth of 1 per cent. of the total, and in 1898 it amounted to only 42,000 tons, or less than 1 per cent. of the total anthracite. Anthracite coal may, therefore, be considered entirely as a Pennsylvania product, since 99·9 of the total is produced there.

The central point of bituminous production is also in the State of Pennsylvania. Of the total of 148,700,000 tons, 58,200,000, or over 40 per cent., were produced in Pennsylvania. The production of this State has very rapidly increased, amounting to only 18,100,000 tons in 1880 and increasing considerably over 200 per cent. in eighteen years. At present (1899) the total production of Pennsylvania, of anthracite and bituminous, ton for ton, is 121,400,000 tons, or 52·6 per cent. of the total, although in 1880 the production was 46,700,000 tons, which, though less, absolutely, formed a large per cent. of the total production of those days, two-thirds of the total coal production having taken place in Pennsylvania at that time. The average percentage for the period of the last twenty years from 1880 to 1899, inclusive, was 55.

The second State in the order of production of coal is Illinois, and this position has been maintained since 1880. At present Illinois produces 20,900,000 tons bituminous coal, which is 11·8 per cent. of the total bituminous, and about 9 per cent. of the total anthracite and bituminous. In 1898, owing to protracted strikes, the production was not so great as for several preceding years, that of 1897 being 17,900,000 tons, or 10 per cent. of the total; and that of 1896 being 17,700,000 tons, or 10·3 per cent. of the total anthracite and bituminous coal production of the country. For the year 1899, according to preliminary figures furnished by the Geological Survey, the output amounted to 20,900,000 tons, an increase over the preceding year's figures by 4,800,000 tons, or about 27 per cent. That the limits of productive capacity have by no means yet been reached is shown by the statement of the secretary of the Illinois State Bureau of Labor Statistics, that the coal mines of Illinois, as at present developed, are capable of producing over 41,000,000 tons. It would appear, then, that the actual output of 1898 was less than half of the possible output, and that a large increase of production in this State is to be looked for during the coming years. The production of Illinois is chiefly in the counties of Sangamon, St. Clair, Vermilion, Macoupin, and Lasalle, these five counties producing considerably over two-fifths of the total production of the State. A large part of this product reaches Chicago by rail, although St. Louis and other inland cities receive considerable shipments.

The third State, in 1898, in the order of coal production, was West Virginia; but this position has been only recently obtained. In 1880 the production of West Virginia was behind not only that of Pennsylvania and Illinois but also that of Ohio and Maryland, and but little in advance of Indiana and Iowa. By 1890, however, West Virginia was already fourth in the order of coal production, and by 1896 third, having exceeded the production of Ohio in that year. In 1880 the production of coal in West Virginia amounted to only 1,800,000 tons, or 2·6 per cent. of the total, whereas in 1899 it amounted to 16,700,000 tons, or 9·5 per cent. of the total bituminous coal production of the country. The chief production is in the counties of Fayette, McDowell, Marion, and Kanawha, whence the famous Kanawha coal comes, over two-thirds of the coal of this State being found in these four counties. A considerable portion of the West Virginia coal is made into coke at home, and the immense possibilities of the region are seen by the very cheap prices which prevail throughout the State, the average price of coal at the mines being only 61 cents, while in McDowell County and elsewhere the prices range but little over 50 cents. A considerable portion of the coal is shipped eastward, while a large amount reaches its market by means of the Ohio River, the Kanawha coal competing with the coals of western Pennsylvania along the Ohio and Mississippi Rivers.

The fourth State in the order of coal production is Ohio, with an output in 1899 of 14,900,000 tons. This output was equal to 6·5 per cent. of the total anthracite and bituminous coal of the country. The production of coal, however, in this region, while it has rapidly increased, has not maintained the same rate of increase as in other parts of the country. Thus, as

early as 1880, the coal production from this region amounted to 5,900,000 tons, or about 8·4 per cent. of the total, as compared to only 6·5 per cent. in 1899. Until 1896 Ohio was third in the order of coal production, but it has since lost this position to West Virginia, and there is no probability of its rapidly regaining it. The production is chiefly in the counties of Perry, Athens, Jackson, Guernsey, and Belmont, although the coal fields of Ohio cover a very large area.

These four States—Pennsylvania, Illinois, West Virginia and Ohio—may be said to be in the first rank of coal producers, the total production from these States amounting in 1899 to 173,900,000 tons, or about 75·3 per cent. of the total coal production of the country. The remaining 24·7 per cent. of the coal produced in this country is distributed as follows: Alabama, which has increased its production almost twenty-fold since 1880, is fifth, with a production of 6,500,000, or almost 3 per cent.; Indiana, whose coal fields adjoin those of Illinois, with 5,800,000 tons, or 2·2 per cent. of the total; Iowa, with 4,700,000 tons, or a little over 2 per cent. of the total; Kentucky, with 4,600,000 tons, or about 2 per cent. of the total; Wyoming, with 4,100,000 tons, having increased its production during the last year 1,700,000 tons, or almost 58 per cent. more than the preceding year's figures, 1·6 per cent. of the total; Missouri, with 3,400,000 tons, or 1·5 per cent. of the total; Kansas, with 3,500,000 tons, or 1·4 per cent. of the total; Tennessee, with 3,000,000 tons, or 1·3 per cent. of the total production; while each of the other States has less than 1 per cent. of the total production. The chief production, however, is in the Middle States, the four States of Maryland, Ohio, Pennsylvania, and West Virginia producing 157,000,000 tons, or about 70 per cent. of the total, while, with the addition of Illinois and Indiana, the coal production of this region is over four-fifths of the total of the country.

The concentration of coal production in the East, while the population is moving so rapidly to the West, has presented the problem of coal transportation, which, owing to the immense bulk of the article, is one of the most difficult of all articles to transport. The movement of coal in this country has mainly been from the East to the West, and the question of transportation from the mines in the Middle States, not only westward to the utmost confines of population in the Western States, but also, although to a less extent, to New England and the eastern part of Canada, presents difficulties which have taxed to the utmost the transportation systems of the country. The movement westward has been effected both by rail and lake as well as by river.

PRODUCTION OF OXYGENIZED WATER BY BARIUM BIOXIDE AND CARBONIC ACID AND THE RENEWAL OF THE BARIUM BIOXIDE.

By M. MOISSAN.

IN a vat closed by a cover is placed a hollow vertical shaft, having in its lower part two hollow branches pierced with small holes underneath. A rotary motion is given to the shaft.

The vat is filled with water to a certain height by means of a funnel. The carbonic acid is brought from a gasometer by means of a suction pump into the hollow shaft and the arms near the bottom of the vat. At the same time, through a special opening, the barium bioxide in powder or solution is introduced.

The acid gas coming through the little holes is diffused in small bubbles through the liquid mass, and on ascending meets the particles of barium bioxide, which it decomposes, seizing on the baryta to form barium carbonate, and setting free an equivalent of oxygen, which unites into combination with the water and thus forms oxygenized water. Vertical plates are fixed on the walls of the vat, preventing the liquid from taking a rotary movement, which the moving shaft would communicate to it. When the water is sufficiently charged with oxygen, the oxygenized water and the barium carbonate which it contains in suspension are sent by a pump to a press filter.

The oxygenized water, coming from the press filter, contains barium carbonate in solution, which is got rid of by adding an equivalent of dilute sulphuric acid.

The barium carbonate is mixed with an equivalent of charcoal and put into crucibles, which are placed in retorts prepared as for gas lighting. There the barium carbonate is submitted to the action of heat sufficient to decompose it into carbon oxide, which is disengaged, and baryta, which remains in the crucible. The baryta drawn from the crucibles is introduced into porcelain tubes, placed in a furnace, and is submitted to the action of a current of air. At a dark red heat it is converted into barium bioxide by absorbing the oxygen of the air.—Translated from La Reine des Produits Chimiques.

NEW APPLICATION OF COLD.

THE Zeitschrift für die gesammuet Kohlensäure Industrie reports on a new employment of cold in the production of condensed milk. While heretofore the percentage of water in the milk was reduced by evaporation under a vacuum from 85 to 87 per cent. to about 28 to 30 per cent., the elimination is in this new process conducted in a separator with simultaneous action of cold. After the milk has been skimmed it enters the centrifugal and is now alternately frozen and thawed out during the rotation which causes the separation of the water from the other constituents of the milk. Before putting up the milk thus dehydrated, the previously removed cream is again added. The taste is said to closely resemble that of fresh milk.

Salt Prices in Germany.—Consul Warner reports from Leipzig, July 26, 1900, that on the first of July, 1900, the price of salt in Germany was advanced from 8 marks to 8 70 marks ($1.90 to $2.07) per 120 pounds. The salt mines of the country are owned and operated by the government. The increase is attributed to the rise in the price of labor.

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TABLE OF CONTENTS.

PAGE

I. ARCHÆOLOGY.—The Mycenæan House of the Double-Ax 20680
The Oldest Library in the World 20679

II. ARCHITECTURE.—The "Tour du Monde" at the Paris Exposition.—1 illustration 20671

III. CHEMISTRY.—Production of Oxygenized Water by Barium Bioxide and Carbonic Acid and the Renewal of the Barium Bioxide.—By M. MOISSAN 20686

IV. COMMERCE.—American Trade and Shipping 20683
Trade Suggestions from United States Consuls 20677

V. EDUCATION.—The Mission of Science in Education.—By JOHN M. COULTER 20681

VI. ELECTRICITY.—Contemporary Electrical Science 20675

VII. FOOD SUPPLY.—Cod Fisheries of the Northern Pacific 20678

VIII. FUELS.—The Coal Trade of the United States and the World's Coal Supply and Trade.—1 diagram 20684

IX. MECHANICAL ENGINEERING.—American Engineering Competition.—X.—Stationary Engines 20672
Mechanical Stoking.—II.—The Roney Mechanical Stoker.—6 illustrations 20673

X. MISCELLANEOUS:
Trade Notes and Receipts 20676
Selected Formulæ 20676

XI. NATURAL HISTORY.—How a Lion Attacks an African Kraal.—1 illustration 20678

XII. OPTICS.—A Simplified Telemicroscope and Solar Microscope.—2 illustrations 20683

XIII. PHOTOGRAPHY.—The History of Photography in Natural Colors 20671

XIV. PHYSICAL GEOGRAPHY.—The Latest Eruption of Vesuvius.—3 illustrations 20679

XV. RAILWAY ENGINEERING.—Railways in Spain 20674

XVI. WARFARE.—The German Squadron in China.—1 illustration 20682

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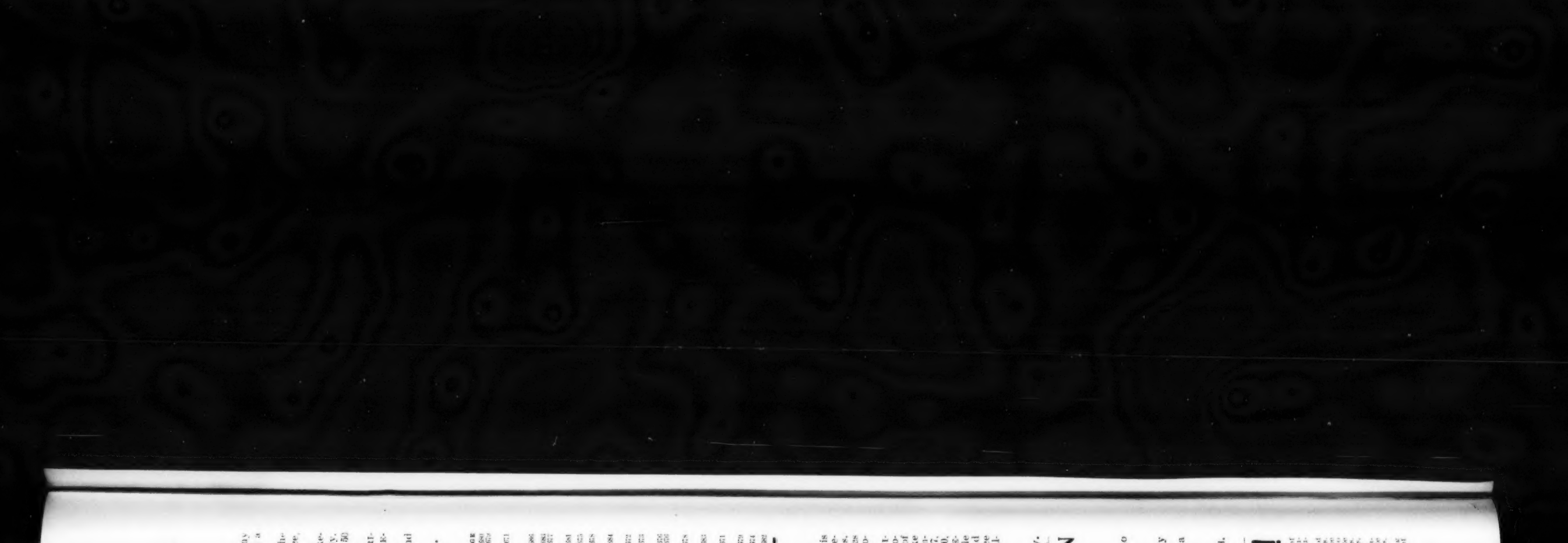
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